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INFORMATION FLOW ANALYSIS OF THE MARINE AIR COMMAND AND CONTROL SYSTEM

A thesis presented to the Faculty of the U.S. Army Command and General Staff College in partial fulfillment of the requirements for the degree

MASTER OF MILITARY ART AND SCIENCE

by

JOSEPH E. NOBLE, MAJ, USMC
B.S., Kansas State University, 1975

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This analysis is based on a model of the Marine Air Command and Control System identified in the Center for Naval Analysis study C3 Information Flow Model. The study was the composited result of a working conference of subject matter experts required to identify the operators, information, and communication paths used by the Marine Air Command and Control System. The model was reduced to a numeric data base from which an analysis of the model's performance as an information exchange system could be evaluated. The timeliness, accuracy, and efficiency of the information flow was then examined based on the numeric reduction of the model.

Among the many conclusions which could be drawn from the analysis are: the model could exchange limited volumes of information in a timely, accurate, and efficient manner; as the volume of information requirements goes up in high intensity air operations, the system identified in the model will most likely fail to provide timely, or accurate, or efficient information flow; the absence of a formalized architecture for the Marine Air Command and Control System has allowed the system to evolve in a piece-meal fashion resulting in the suspicion supported by the analysis that the system is flawed to perform as required in high intensity operations.

The analysis concludes that the requirement and architecture for the Marine Air Command and Control System needs formalization. Development of a Required Operational Capability and a Concept of Employment should proceed while study of the system continues to formalize the architecture required for the Marine Air Command and Control System.

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The opinions and conclusions expressed herein are those of the student author and do not necessarily represent the views of the U.S. Army Command and General Staff College or any other governmental agency. (References to this study should include the foregoing statement.)

ABSTRACT

INFORMATION FLOW ANALYSIS OF THE MARINE AIR COMMAND AND CONTROL SYSTEM, by Major Joseph E. Noble, USMC, 146 pages.

This analysis is based on a model of the Marine Air Command and Control System identified in the Center for Naval Analysis study C3 Information Flow Model. The study was the composited result of a working conference of subject matter experts required to identify the operators, information, and communication paths used by the Marine Air Command and Control System. The model was reduced to a numeric data base from which an analysis of the model's performance as an information exchange system could be evaluated. The timeliness, accuracy, and efficiency of the information flow was then examined based on the numeric reduction of the model.

Among the many conclusions which could be drawn from the analysis are: the model could exchange limited volumes of information in a timely, accurate, and efficient manner; as the volume of information requirements goes up in high intensity air operations, the system as identified in the model will most likely fail to provide timely, or accurate, or efficient information flow; the absence of a formalized architecture for the Marine Air Command and Control System has allowed the system to evolve in a piece-meal fashion resulting in the suspicion supported by the analysis that the system is flawed to perform as required in high intensity operations.

The analysis concludes that the requirement and architecture for the Marine Air Command and Control System needs formalization. Development of a Required Operational Capability and a Concept of Employment should proceed while study of the system continues to formalize the architecture required for the Marine Air Command and Control System.

ACKNOWLEDGEMENTS

The identification of the need for improvement in the Marine Air Command and Control System has had many sources. The support of Lieutenant General K.A. Smith as the basic force in this on-going effort has been crucial. The efforts of Marine Aviation Weapons and Tactics Squadron One, and the Marine Corps Operational Analysis Group in the Center for Naval Analysis, have provided the impetus to the effort, and were of invaluable assistance in the development of this analysis. Numerous Fleet Marine Force subject matter experts provided their insights and inputs to the effort, and their support is greatly appreciated.

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CHAPTER 1

INTRODUCTION

The Marine Air Command and Control System (MACCS) provides the Marine Air Ground Task Force (MAGTF) commander the means to plan, coordinate, control, and prosecute the air battle in support of ground operations. Essential to effective MACCS operations is the timely, accurate, and efficient transfer of information between agencies of the MACCS.

The purpose of this thesis was to examine how critical information flows within the Marine Air Command and Control System, and to answer the question, "Does information essential to the successful prosecution of the Marine Air Ground Task Force's air battle flow through the MACCS in a timely, accurate, and efficient manner?" This question, asked by increasing numbers of senior Marine commanders, has been raised by deficiencies perceived in the system during high intensity air operations simulating combat conditions. It appears that as operational tempo increases, the command and control system actually passes less and less information. To gain an understanding of the question, and of the Marine Air Command and Control System, we must first examine the evolution of the current system.

Marines have been involved with aviation, and its tactical employment, since 1912. Air control was first conducted during the Marine expeditionary involvement in Nicaragua during the late 1920's. Marine aircraft, in radio contact with Marines on the ground, conducted what is commonly acknowledged as the first true close air support missions flown by U.S. forces. Through the 1930's and World War II, control procedures for close air support continued to be refined. It was during WW II that Marine aircraft first conducted Ground Control Intercept (GCI) of hostile aircraft controlled by the newly developed radars of the Navy. Ashore, Marine forces began developing procedures and methods for coordinating the employment of antiaircraft guns against hostile aircraft with Marine fighter and close air support aircraft. The control procedures developed during World War II, with little revision, were used in the Korean War. After the Korean War and into the early 1960's Marines began acquiring newer, more capable aircraft and the first generation of expeditionary radars to be employed ashore to control Marine aviation.[1] By the mid-1960's, the first surface-to-air missile units were fielded to replace the outdated antiaircraft guns.

These increased operational capabilities required enhanced control capabilities, and the forerunner of the current Marine Air Command and Control System was based around a manually operated centralized planning and

coordination agency called the Tactical Air Command Center. Subordinate to it were two agencies -- one to control air defense, and one to control close air support aircraft and helicopters. The air defense agency had radars from which intercepts of hostile aircraft could be controlled, and was called the Tactical Air Operations Center. The close air support/helicopter control agency simply used radios and status boards (not radars) to manage and control their aircraft, and was called the Direct Air Support Center. One radar capability subordinate to the DASC was available to control close air support aircraft and helicopters during adverse weather or at night called the Air Support Radar Team. Surface-to-air missile units were to be controlled by the same agency as fighter aircraft, the Tactical Air Operations Center.

This air control system, augmented by air traffic control radars at the airfields, controlled Marine aviation assets employed in Viet Nam. However, it was realized that the manually operated system was too slow in processing critical information. Improvements were developed for the system by adding automated (computer-assisted) information processing to better track aircraft on the radars, and to control surface-to-air missile units. These improvements were fielded in the early 1970's for the Tactical Air Operation Center and Tactical Air Command Center, but no significant changes were made for the Direct Air Support Center. Automated

support was primarily focused on enhancing air track management. The majority of information exchanged within the system was manual, via radios and messages. At no point was the system's design parameters, or architecture, ever formalized. Neither was the information which the system needed, or was expected to exchange, ever formalized. From the early 1970's to the present, several generations of enhanced equipment have been fielded but still the issue of a formal architecture for the system and its information flow requirements was left unresolved.

In the dynamic, rapidly changing battlefield of tommorow, the timely and efficient operation of the Marine Air Command and Control System will be essential for successful Marine operations. Realizing this, in 1986 the Deputy Chief of Staff for Aviation at Headquarters, U.S. Marine Corps, chartered a study of the MACCS in order to formalize the structure for future analysis and identification of system requirements.[a] The results of this MACCS structure study were published[a], and from it, the question of how the system works, and whether it is efficient, can be addressed. The results of an analysis of how information flows within the MACCS may be used to modify the existing system, to validate/modify current training of MACCS personnel, and to identify future acquisition requirements for the MACCS.

Certain assumptions are made for the purpose of conducting this analysis. First, the current Marine Air

Command and Control System has evolved without a formal architecture. Second, the absence of a formal architecture has allowed the MACCS to evolve as a less than efficient information exchange system. Third, timely, accurate, and efficient information flow within the MACCS is essential to the success of Marine Aviation operations. Fourth, although the MACCS handles a wide variety of information, certain information is "critical" to the success of Marine operations. And last, the MACCS structure study provides a basis for the analysis of information flow within the MACCS.

The Marine Air Command and Control System has a vernacular all its own which must be understood for the analysis to be understood. The most frequently used terms relating to the MACCS, and their definition, are :[4]

Tactical Air Command Center (TACC): The TACC is the senior MACCS agency. It provides the personnel and facilities for the Tactical Air Commander to direct all Marine Air Ground Task Force tactical air operations.

Tactical Air Operations Center (TAOC): The TAOC is the primary air defense/ AAW agency within the MACCS. The TAOC gathers information on the overall air picture and makes timely decisions regarding the commitment of resources. The TAOC coordinates air-to-air and surface-to-air engagements to maintain air superiority.

Direct Air Support Center (DASC): The DASC is the principal air control agency responsible for the direction

of air operations supporting ground forces. The DASC processes requests for immediate air support, controls aircraft transiting its area of responsibility, and coordinates air missions requiring integration with the ground forces, including close air support, close in fire support, assault support, and designated air reconnaissance missions.

Air Support Radar Team (ASRT): The ASRT is a terminal air control agency subordinate to the Direct Air Support Center (DASC). It is a precision control radar with associated computer equipment designed to accurately position aircraft without visual reference to the earth's surface.

Light Anti-Aircraft Missile (LAAM) units: LAAM units provide medium-range, low-to-medium altitude surface-to-air missile units to defend assigned areas of operations or installations and vital zones against high-speed, low-to-medium altitude hostile aircraft and missiles.

Low Altitude Air Defense (LAAD) units: LAAD units provide short-range, low-altitude air defense for the Marine Air Ground Task Force, including protection for units operating in forward combat areas or engaged in special independent operations.

Marine Air Traffic Control Squadron (MATCS): The MATCS provides continuous all-weather air traffic

control service for Expeditionary Air Fields and limited support for forward area landing sites.

Tactical Air Coordinator (Airborne) [TAC(A)]: The TAC(A) is an officer who coordinates the action of combat aircraft engaged in close support of ground or sea forces.

Helicopter Coordinator (Airborne) [HC(A)]: The HC(A) is an experienced naval aviator operating from an aircraft to direct airborne coordination and control of helicopterborne assaults.

Forward Air Controller (FAC): The FAC is an officer member of the Tactical Air Control Party who, from a forward ground position, controls aircraft engaged in Close Air Support (CAS) in support of ground forces. If he performs his functions from an aircraft, the FAC is refered to as a Forward Air Controller (Airborne) [FAC(A)].

With these basic definitions of the major components of the Marine Air Command and Control System in mind, the basics of an information flow analysis can now be discussed.

To conduct an information flow analysis, the components which make up an information exchange system need to be identified. There are three basic components to any information exchange system: operators who require information for their job, the medium or path by which they acquire their needed information, and the information

itself that the system is exchanging. For modeling purposes it does not matter if the exchange system is computer-assisted, strictly manual, or a combination of both. Equipment, hardware, or software are of no concern. For this study it is important only to identify: who the system operators are, their assigned tasks, the information they require to successfully accomplish those tasks, and how they will gain access to that information.* With these facts in hand, the analyst can then begin to establish a model of the information exchange system. With the model established, an evaluation process of the system can be conducted to determine if it does in fact perform the information exchange functions for which it was designed, and how efficienctly it performs those functions.

Certain limitations and delimitations affected this analysis of information flow within the Marine Air Command and Control System. The significant limitation was the paucity of literature addressing either the structure of the MACCS or the information flow within the MACCS. The limited references forced this analysis to depend on a limited body of information, which may inadvertantly cause some of the analysis's results to be biased or stilted. Certain delimitations had to be set on the analysis. First, the tremendous volume of information processed by the Marine Air Command and Control System was too great for this analysis to evaluate. Specific critical informa-

tion which the system must exchange was identified and used for the analysis. Second, although the MACCS does exchange some of this information with Joint/ Combined air control agencies, the analysis was limited to information flow within the Marine Corps only.

The significance of my information flow analysis of the Marine Air Command and Control System is that for the first time a detailed statistical performance evaluation of an information flow model of the MACCS has been completed. The Center for Naval Analysis study, which will be discussed later, provided an internal, "micro" look at the structure of information flow within the MACCS. With this thesis statisticly quantifying how the system model performs, areas where the model needs improvements, or that the system needs to be made more efficient, can be identified. Expanding the existing body of knowledge on this subject might in and of itself justify the significance of this thesis since the existing sources of information are so scarce. But quantifying critical information nodes within the MACCS, and the relative efficiency at which those nodes perform, is critical to a thorough evaluation of the MACCS. The complexity and speed of air operations on the modern battlefield make the timely acquisition of information imperative for efficient battle management. This analysis should assist in ensuring that the performance of the Marine Air Command and Control System will be equal to the task.

END NOTES

[1]Peter B. Mersky, U.S. Marine Corps Aviation - 1912 to the Present, (1983): 310 pages.

[2]U.S. Marine Corps, Program Objective Action Memorandum for Deputy Chief of Staff for Aviation, June 17, 1986: 2 pages.

[3]Center for Naval Analysis, C3 Information Flow Model, (1987): 210 pages.

[4]U.S. Marine Corps, OH 5-8, Control of Aircraft and Missiles, (1987): 93 pages.

[5]Marine Aviation Weapons and Tactics Squadron One, Air Defense Information Flow Model and Analysis, (1987): 216 pages.

CHAPTER 2

SURVEY OF THE LITERATURE

The body of literature which addresses the structure and organization of the Marine Air Command and Control System (MACCS), information requirements of the system, and how information flows within the system, is extremely limited. A number of doctrinal manuals and publications address the MACCS and what roles and tasks its agencies are expected to perform in various scenarios. However, these publications do not address the specific areas of structure and information flow within the system. Only the publications which address subjects will be discussed in this survey.

Peter B. Mersky's, U.S. Marine Corps Aviation - 1912 to the Present, (1983): 310 pages, provided an excellent historical perspective of the evolution of Marine aviation, though only limited insight into the evolution of the Marine Air Command and Control System was provided. By closely studying the material, a framework for the earliest start of air control can be extracted. Moreover, the subject is largely ignored during the critical period of the 1950's and 1960's when the system that exists today was in its formative stages. Therefore, the book had little direct

value in providing information pertinent to the thesis question.

U.S. Marine Corps, FMFM 5-1, Marine Aviation, (1979): 321 pages, contains the most complete information on Marine aviation and its component parts of any publication surveyed. The manual includes a historical perspective of Marine aviation, its functions and terminology, and extensive information on Marine Aviation organizations and missions, equipment and systems, and its planning requirements for employment in combat. The Marine Air Command and Control System was specifically addressed, with each of its functions and organizations discussed individually. It should be considered the baseline reference for learning about Marine aviation and its capabilities as well as the baseline reference for learning about the Marine Air Command and Control System within the context of Marine aviation as a whole. The manual did not, however, address the internal structure of the agencies of the MACCS, the roles and tasks of its operators, or information flow responsibilities and requirements of the system. The manual should be considered as the introductory reference for knowledge about the Marine Air Command and Control System.

U.S. Marine Corps, OH 5-5 Antiair Warfare, (1987): 148 pages, contained detailed information on how the Marine Corps plans to conduct Antiair Warfare operations. The handbook discussed in detail how Marine aviation will conduct

Antiair Warfare through the different phases of amphibious operations, and how the components of the Marine Air Command and Control System involved in the Antiair Warfare mission are expected to function. Most importantly for this thesis, it addressed specificly the key operators in the MACCS involved in Antiair Warfare operations, and addressed specific tasks they are expected to perform. The handbook was a critical supporting document in validating the key operators in the MACCS, and the tasks they perform.

U.S. Marine Corps, OH 5-8 Control of Aircraft and Missiles, (1987): 93 pages, provides the most detailed information pertinent to the thesis. It provides a detailed examination of the Marine Air Command and Control System and its component parts. The handbook identified the crew organization of each agency, and identified each crew member's primary tasks and responsibilities. It includes in an appendix the communication paths employed by the system. For a single source document detailing the Marine Air Command and Control System, this handbook is the one recommended. Fom it, two of the three components of the information flow model can either be derived, or validated. It identifies the operators and the medium available over which information is acquired, but does not address which operator uses each medium, neither does it address at all what information each operator needs. This handbook was one of the three primary sources used in the thesis.

Marine Aviation Weapons and Tactics Squadron One, Air Defense Information Flow Model and Analysis, (1987): 216 pages, was the second of the three primary sources used in the thesis. It contains an information flow model of the components of the Marine Air Command and Control System involved with the air defense mission. It was the first document published to address an information flow model of the MACCS, and established the basic parameters of the modeling effort. The model identifies the critical MACCS operators, the critical information the system must exchange, and the primary paths over which the information was exchanged. It then details which operator needed each piece of information, and which path each operator accesses. The document presents the analysis of the model's performance based on data acquired by observing the model perform during live operations conducted in two Weapons and Tactics Instructor Courses. The analysis provides conclusions on the model's performance, and recommends continued analysis. Although not addressing the complete MACCS in the model, this document provided the framework from which the next document surveyed was derived.

Center for Naval Analysis, C3 Information Flow Model, (1987): 210 pages, was the last of the three primary sources used in the thesis, and was in fact the most important of the three. This model was the result of the tasking by the Deputy Chief of Staff for Aviation, Headquarters, U.S. Marine Corps, for the structure of the Marine Air Command

and Control System to be researched and formalized. Using the Air Defense Information Flow Model and Analysis as an example and point of departure, analysts from the Center for Naval Analysis worked with MACCS representatives to establish an information flow model of the entire Marine Air Command and Control System. The results of their work was published in this document. The model detailed all of the key operators in the MACCS, including key aviation personnel who are within the information exchange process. It identified the major information elements the system must exchange for successful Marine Aviation operations. The model provided a detailed list of all of the information exchange mediums or paths available to the system and its operators. The majority of the document was then diagrams showing information passing between operators over specific paths. Although text explaining each diagram was not included, the diagrams were fairly self-explanatory. These diagrams are the only source detailing how information is exchanged in the Marine Air Command and Control System. Therefore, they were the basis for the preponderance of the analysis conducted in this thesis. A detailed explanation of the model established in the study, including the major components used in this analysis, was included in Chapter 3 of this thesis.

The author of this thesis has twelve years of experience in Marine Air Command and Control System operations.

Assignments have included command of a Light Antiaircraft Missile unit, command of a Low Altitude Air Defense unit, experience on crew in the Tactical Air Command Center, Tactical Air Operations Center, and Direct Air Support Center, and two years as a Marine Air Command and Control System instructor. Working as a C3 system analyst, and as author of the Air Defense Information Flow Model and Analysis, the author participated in the Center for Naval Analysis study from which this thesis was derived. This thesis is the continuation of previous efforts to determine how information flowed within the MACCS, and to determine how efficiently the information flow was conducted. The results of this thesis should provide an additional level of understanding on this complex issue.

CHAPTER 3

METHODOLOGY

The methodology selected to examine the thesis question is to reduce the Marine Air Command and Control System model in the Center for Naval Analysis (CNA) study into a numeric data base from which evaluations can be made. An explanation of the MACCS model in the CNA study will provide clarification of this methodology.

The CNA model consisted of a listing of MACCS operators and the basic tasks they perform in the system, a listing of paths or mediums by which the operators acquire or exchange information, and a listing of the information elements deemed to be most critical to Marine aviation operations. These listings form the basis from which the MACCS model was built. The operator listing was converted into diagrams showing the operators' locations within their respective agency. Each element on the information listing was then looked at independently to determine each operator which either required that information or, as a function of his job, routinely was required to exchange that information within his own agency or with another agency. Finally, each diagram was completed by showing the

path or medium by which each operator accessed the information. This was represented by lines connecting each operator and his source of the information, and by labeling each connecting line with the path used. The end product was a rather voluminous document of diagrams of the MACCS information exchange system. The diagrams were presented in the order by information element with a complete set of system diagrams provided for each information element.

The unique nature of the CNA study should be explained. It was the first study based on practical field experience (instead of theoretical supposition) of how information is exchanged by the MACCS. Any previous work only outlined the system partly by discussing information exchange between agencies, not between the operators within the agencies. The flaws in these previous works were manifested in the operators' field experiences where information came into an agency but no single operator was either responsible for exchanging it, or, in some cases, no operator in the agency even required it; in other cases, critical information needed by an operator could not be acquired because his agency was not shown to need the information; in addition, the specific path by which each operator would acquire his needed information was never previously identified. These flaws in previous works were all addressed in the method by which the CNA study was constructed. For the first time, the inner workings of information exchange within the MACCS can be evaluated in detail.

The specifics of the various listings are essential in evaluating the CNA model. Each of the three listings -- operators, paths, and information -- will be discussed.

The operator listing provides the key component of the information exchange system -- the "who" component. The operator listing with the short title or abbreviation for each operator and a brief explanation of each operator's information exchange tasks or responsibilities is provided to establish the information flow model's framework. This listing will be presented by functional organization or agency. It should be noted here that some organizations not normally considered a part of MACCS information flow (such as the Aviation Combat Element headquarters) are included in the model. Their inclusion is based on either their need for information which resides in the MACCS, or because in some cases they are the source of information needed by MACCS operators. The operator listing used in the model was:

Aviation Combat Element (ACE) Crew Positions

ACE Headquarters

1. G-1 Officer. Responsible for aircrew/personnel replacements, maintaining and disseminating reports, and coordinating messages and their routing.
2. G-2 Officer. Maintains and disseminates enemy air order of battle, threat analyses,

collected products, Bomb Damage Assessment (BDA)/engagement reports, weather reports; conducts or assembles pilot debriefs.

3. G-3 Officer. Plans and executes ACE mission; maintains availibility of aircraft/system/ on-board ordnance and friendly situation.
4. G-3 Operations Officer (G-3 Ops Officer). Responsible for current planning and execution of ACE mission; distributing the Air Tasking Order (ATO); responsible for availability and allocation of assets, situation information, BDAs, rules of engagement, and weather updates.
5. G-3 Plans Officer. Responsible for developing ACE plans; maintaining situation information (current and projected), availability of assets; coordinating tasking.
6. G-3 Fixed Wing/Rotary Wing Fragger (G-3 FW/ RW Fragger). Maintains current plan; publishes ATO/ Fragmentary Order (FRAG); responsible for tasking, air request coordination, mission timing and routing, mission communication plans and coordinating instructions, and maintaining situation information.
7. G-3 Weapons Employment Officer (G-3 WEO). Responsible for weaponeering plans, coordinates

availability of ordnance/platforms/systems, and maintains rules of engagement and BDAs.

8. G-3 Air Control Officer (G-3 ACO). Plans and supervises the MACCS and its configuration; coordinates air control procedures/routing/ communication plans/coordination instructions; maintains MACCS status and Return to Force (RTF) procedures.
9. G-3 Command, Control and Communications Counter Measures Officer (G-3 C3CMO). Responsible for C3CM planning and execution; coordinating communication plans/electronic plans/ deception plans; maintaining enemy C3CM capability information.
10. Communications-Electronic Officer (Comm Elec Officer). Coordinates communication plans and execution, electronic plans and execution, deception plan, and communication and electronic configurations.
11. G-4 Officer. Tasks and coordinates logistic support and the use of facilities including airfields and forward bases.
12. Ordnance Officer. Maintains availability of aviation ordnance/resupply/personnel status, and monitors ordnance equipment status.

13. Aviation Maintenance Officer (AMO). Responsible for aircraft/system availability and maintains status of support equipment and personnel.

Marine Aircraft Group (MAG) Headquarters

1. S-1 Officer. Coordinates aircrew/personnel replacements, maintains reports, and coordinates message traffic and routing.
2. S-2 Officer. Maintains threat situation, weather updates, map studies, and friendly situation.
3. S-3 Officer. Responsible to accomplish ACE tasking; the allocation and availability of assets; coordinating rules of engagement/ATO/FRAGS; maintaining friendly situation.
4. S-3 Plans Officer. Assists in development of ACE plans; maintains situation information, weather updates, aircrew availability, aircraft, systems, and ordnance availability; coordinates ACE tasking.
5. S-3 Fragger. Coordinates ATO, and maintains asset availability including aircraft, system, and ordnance.
6. S-3 Weapons Employment Officer (S-3 WEO). Validates and recommends weaponeering plans, coordinates availability of ordnance/plat-

forms/systems, and maintains rules of engagement and BDAs.

7. S-4 Officer. Responsible for logistic support and facilities coordination.
8. Ordnance Officer. Plans for and maintains availability of aviation ordnance, and coordinates ordnance build up and aircraft weapon system maintenance.
9. Aviation Maintenance Officer (AMO). Responsible for aircraft and systems availability, predicts future availability, and maintains status of support equipment/personnel.

Squadron Headquarters

1. S-1 Officer. Coordinates aircrew/personnel replacements and message traffic, and maintains reports.
2. S-2 Officer. Maintains threat situation, weather updates, map studies, friendly situation; debriefs aircrew.
3. S-3 Officer. Allocates assets to fullfill tasking; coordinates rules of engagement, ATO and FRAG; maintains friendly situation; responsible for the availability of assets.
4. Flight Officer. Coordinates ATO, flight schedules, crew training; maintains asset availability including aircraft, aircrew, systems, and ordnance.

5. Weapons and Tactics Instructor (WTI). Coordinates FRAG; maintains enemy situation, ordnance availability, and aircraft availability.
6. Operations Duty Officer (Ops Duty Officer or ODO). Coordinates and supervises flight schedule; maintains rules of engagement, asset availability, and weather updates.
7. S-4 Officer. Provides logistic support, and coordinates facilities.
8. Ordnance Officer. Maintains aviation ordnance, asset availability, resupply, personnel status, maintenance status, ordnance equipment status; coordinates the ordnance build up and aircraft weapon system maintenance.
9. Aviation Maintenance Officer (AMO). Responsible for the availability of aircraft and systems, and maintains status of support equipment/personnel.
10. Aircrew. Operate tactical aircraft.

Tactical Air Command Center (TACC) Crew

1. Tactical Air Commander (TAC). Coordinates all ACE operations with MAGTF and Ground Combat Element (GCE) Combat Operations Centers and external agencies; functions as air defense commander/Fleet Antiair Warfare

Commander (FAAWC)/airspace control authority; establishes readiness state, alert conditions, emission control conditions.

2. Senior Air Coordinator (SAC). Executes TAC's orders by coordinating functions of TACC's operations section; monitors subordinate agencies' reports; supervises the employment of air defense and air support assets, and the proper dissemination to subordinate units of all essential information.
3. Air Defense Coordinator (ADC). Monitors and coordinates the control of aircraft and missiles for air defense by subordinate agencies; manages air defense aircraft; monitors status of air defense agencies' equipment; ensures displays are current and keeps SAC briefed.
4. Air Defense Recorder (ADR). Assists ADC; maintains air defense records and monitors and updates TACC air defense displays.
5. Air Support Coordinator (ASC). Monitors and coordinates the control of direct air support aicraft by subordinate agencies; manages air support aircraft; monitors status of air support control agencies' equipment; ensures displays are current and keeps SAC briefed.

6. Air Support Recorder (ASR). Assists ASC; maintains air support records, and monitors and updates TACC air support displays.
7. Interface Coordination Officer (ICO). Coordinates ACE data link operations; establishes surveillance sectors and surveillance/identification procedures.
8. Track Data Coordinator (TDC). Coordinates ACE air track reporting with ICO and subordinate agencies; ensures situation display maps are correct and current.
9. Tactical Air Watch Officer (TAWO). Coordinates fixed wing aircraft operations with the MAGs/squadrons/ADC/ASC/Air Boss; recommends changes or cancellations to the ATO.
10. Air Support Watch Officer (ASWO). Coordinates helicopter and air support operations with the MAGs/squadrons/ASC/ADC/Air Boss; recommends changes and cancellations to the ATO.
11. Intelligence Watch Officer (IWO). Coordinates intelligence operations with G-2/S-2 Watch Officers at ACE/MAG/squadron headquarters and with external agencies; disseminates intelligence information to subordinate units/agencies; ensures intelligence status boards are correct and current.

12. Crew Chief (CC). Supervises and assists the recorders and plotters; coordinates with maintenance coordinator to ensure equipment/ communications status board is correct and current.
13. Maintenance Coordinator (MC). Coordinates TACC equipment readiness and communication availability.
14. Plotter. Posts the ATO and aircraft mission status by monitoring appropriate nets.
15. G-3 Watch Officer (G-3 WO). Assists TAC by expediting the employment of air weapon systems; resolves conflicts between current employment and future requirements for air weapon systems.
16. Air Control Officer (ACO). Assists TAC in the employment of the MACCS.
17. Air Boss. Coordinates aircraft availability at the airfield for the TACC; relays information between the TACC and aircrews.

Tactical Air Operations Center (TAOC) Crew

1. Senior Air Director (SAD). Implements air defense plan including Combat Air Patro (CAP) manning, missile engagements, tanker plan, and agency coordination; directs TAOC crew in

controlling air defense battle; supervises information flow.

2. Crew Chief (CC). Supervises maintenance of display boards; processes reports; supervises plotters and net operators.
3. Plotter A. Monitors traffic nets; posts ATO/FRAG; maintains aircraft on-station status; maintains tanker status.
4. Plotter B. Maintains MACCS equipment status; updates weapon release conditions, alert conditions, and communication status.
5. Plotter C. Maintains missile status, CAP status, and air asset status.
6. Surveillance/Identification Director (SID). Processes intelligence information; coordinates and supervises TAOC surveillance operations/identification procedures; coordinates with other directors and other agencies; maintains ATO/FRAG.
7. Track Data Coordinator (TDC). Responsible for data link and symbology management.
8. Surveillance Operator (SO). Responsible for target detection, identification, and classification.
9. Electronic Counter Countermeasures Operator (ECCM Op). Responsible for sensor status and for implementing emission control plan.

10. Senior Traffic Director (STD). Coordinates air traffic between airfields and terminal controller/destination.
11. Tactical Air Traffic Controller (TATC). Provides enroute control; controls aerial refueling; provides hand-off to other controllers.
12. Senior Weapons Director (SWD). Supervises and directs his controllers in controlling air defense assets; evaluates threats and availability of friendly assets; monitors status of air defense agencies/assets.
13. Air Intercept Controller (AIC). Controls CAPs; supervises AWC; assists to identify CAP detected targets; forwards engagement reports.
14. Missile Controller (MC). Coordinates missile engagements; maintains friendly aircraft locations, missile equipment status, resupply status, missile location, communication status; processes engagement reports.
15. Assistant Weapons Controller (AWC). Maintains track data, engagement reports; assists AIC/MC.

Early Warning/Control (EW/C) Crew

1. EW/C Director (EW/C Dir). Coordinates with TAOC; supervises crew; processes intelligence information and engagement reports.
2. Surveillance Operator (SO). Responsible for target detection, identification, and classification.
3. Tactical Air Traffic Controller (TATC). Provides enroute control; controls aerial refueling; provides hand-off to other controllers.
4. Air Intercept Controller (AIC). Controls CAPs; supervises AWC; assists to identify CAP detected targets; forwards engagement reports.
5. Missile Controller (MC). Coordinates missile engagements; maintains friendly aircraft locations, missile equipment status, resupply status, missile location, communication status; processes engagement reports.
6. Assistant Weapons Controller (AWC). Maintains track data, engagement reports; assists AIC/MC.
7. Electronic Counter Countermeasures Operator (ECCM Op). Responsible for sensor status and for implementing emission control plan.

Sector Antiair Warfare Coordinator (SAAWC) Crew

1. SAAWC. Responsible for decentralized execution of air defense plan; assigns weapon systems to engagement zones; provides guidance to TAOC's SAD on deployment and availability of assets.
2. SAAWC Operations Officer (SAAWC OPS Officer). Manages information flow between SAAWC and TAOC/TACC; supervises Crew Chief and plotters; advises SAAWC on operational matters.
3. Crew Chief (CC). Supervises plotters; monitors/manages communication paths.
4. S-2 Officer/Staff Non-Commissioned Officer (SNCO). Provides SAAWC with intelligence updates and interpretations; forwards engagement reports to the TACC.

HAWK Crew Positions

Battalion Command Post (BN CP)

1. S-1 Officer. Plans, coordinates, and supervises personnel strength control, prisoners of war (POW), grave registration functions, and personnel services; selects CP sites.
2. S-2 Officer. Receives and disseminates intelligence information; prepares enemy air order of battle, intelligence estimates, map and terrain studies/trafficability studies.

3. S-3 Officer. Plans, coordinates, and supervises tactical employment of HAWK units; prepares operational and historical reports.
4. Tactical Director (TD). Channels orders to/from fire units and the battalion staff; monitors units' status; initiates required reports.
5. Operations Assistant (Ops Assistant). Assists TD and supervises Journal Recorder.
6. Journal Recorder. Maintains command journal and status boards; records data; drafts messages.
7. Nuclear, Chemical, Biological Non-Commissioned Officer (NBC NCO). Receives and disseminates NBC information; advises the commander on the NBC threat.
8. Communication Operators (Comm Operators). Receives and transmits information on appropriate nets; posts and logs information.
9. Plotter. Maintains situation map and status boards; monitors appropriate nets.
10. Low Altitude Air Defense Representative (LAAD Rep). Coordinates the employment of LAAD units with HAWK units; maintains LAAD status boards; monitors appropriate nets.
11. S-4 Officer. Plans and provides logistic support; task organizes Combat Service Support.

HAWK Base Fire Unit (BFU)

Battery Control Center (BCC)

1. Tactical Control Officer (TCO). Supervises all HAWK system functions; receives information from the TAOC; sends reports to the TAOC.
2. Tactical Control Assistant (TCA). Assists TCO; supervises surveillance and data link operations; monitors required nets with TAOC; maintains status board.
3. Azimuth Speed Operator (ASO). Controls low altitude acquisition radar and console; passes detections to TCA.
4. Firing Console Operator (FCO). Controls illuminating radar, console, launchers, and missiles; engages threat aircraft and reports results to the TCO.

HAWK Assault Fire Unit (AFU)

Platoon Command Post (PCP)

1. Tactical Officer (TO). Controls air defense operations of the AFU's HAWK system; receives information from the TAOC/BCC; reports information to the TAOC/BCC.
2. Radar Operator (RO). Controls the illuminating radar; tracks targets; monitors required nets; assists TO.

3. PCP Operator. Operates computer and identification equipment; monitors data link operation.

Combat Operations Center (COC), BFU or AFU

1. Officer in Charge (OIC). Channels operational, logistical, and administrative requests; monitors and reports status of all unit functions; coordinates with LAAD representative.
2. Communication Operator. Receives and posts information; passes reports and messages; maintains message log and updates status boards.
3. Recorder/Plotter. Monitors appropriate nets; maintains situation map; coordinates with LAAD representative.
4. Ground Defense Non-Commissioned Officer in Charge (GD NCOIC). Initiates perimeter defense and reaction force; maintains site defense map.
5. Nuclear, Chemical, Biological Non-Commissioned Officer in Charge (NBC NCOIC). Receives and reports NBC information; maintains NBC/ground situation map.
6. Low Altitude Air Defense (LAAD) Representative. Monitors required nets; maintains LAAD status

board and map; coordinates LAAD employment with HAWK units.

Low Altitude Air Defense (LAAD) Crew

Battalion/Battery Information Center (BIC)

1. Officer in Charge (OIC). Coordinates placement of LAAD units; passes surveillance information; monitors appropriate nets; maintains status information; advises TAC and SAAWC on LAAD employment.
2. Administrative/Logistics Operator (Admin/Log). Coordinates missile resupply , vehicle and administrative support.
3. Asset Plotter. Plots LAAD unit locations and missile status; maintains equipment and communication status.
4. Track Plotter. Plots detections from all sources; disseminates track information to the tactical platoons.

LAAD Tactical Platoons

1. Platoon Commander/Sergeant. Advises commanders on LAAD employment; coordinates with other air defense units; passes surveillance information to LAAD sections and MACCS; passes reports and status information to the BIC and MACCS.
2. Section leader. Responsible for section employment; passes early warning and control

information to sections; passes reports and status information to platoon commander/ sergeant.

3. Section Communication Operator. Passes all information between section leader and his teams, and the section leader and the platoon commander/sergeant.
4. Team leader. Responsible for team employment; maintains communication with section leader; detects, identifies, engages and reports low flying aircraft; reports team location and status.

Direct Air Support Center (DASC) Crew

1. Senior Air Director (SAD). Responsible for functioning of DASC's crew; coordinates with agencies external to the DASC; maintains log of all key events; maintains and disseminates all information pertinent to the DASC's functions.
2. Tactical Air Director (TAD). Responsible for the management and direction of all fixed wing aircraft operating in the DASC's area of responsibility; maintains required communication nets; maintains and disseminates information pertinent to fixed wing operations.

3. Helicopter Director (HD). Responsible for the management and direction of all rotary wing aircraft operating in the DASC's area of responsibility; maintains required communication nets; maintains and disseminates information pertinent to rotary wing operations.
4. Crew Chief (CC). Supervises DASC crew; receives, maintains, and disseminates information from crew members; coordinates with other MACCS agencies as required.
5. Tactical Air Request/Helicopter Request Net Operator (TAR/HR). Receives, processes, and forwards air requests; maintains required communication nets; coordinates with terminal controllers; maintains record on all air requests; receives combat information from terminal controllers and passes it to the CC.
6. Direct Air Support Net Operator (DAS). Passes and receives information to/from the TACC; maintains required nets; logs all transmitted/received information; coordinates forward site operations.
7. Tactical Air Command Net Operator (TAC). Conducts MACCS agency coordination as directed; passes and receives information with

other MACCS agencies; maintains required communication nets; records all exchanged information.

8. Air Support Radar Team (ASRT) Control Net Operator (ACN). Exchanges information with the ASRT; maintains required communication nets; records all exchanged information.
9. Plotter. Plots information received from DASC supervisory personnel.

Fire Support Coordination Center (FSCC) Crew

1. Tactical Air Control Party (TACP)/Forward Air Controller (FAC). Requests air support; controls aircraft; maintains required communication nets; passes mission effectiveness reports to the DASC.
2. Battalion Fire Support Coordinator (Bn FSC). Recommends fire support measures; plots artillery locations and naval gunfire locations.
3. Battalion Air Officer (Bn AO). Coordinates air control measures and air requests with fire support agencies; monitors required communication nets; receives and forwards mission effectiveness reports; updates status boards.
4. Regimental Fire Support Coordinator (Regt FSC). Recommends fire support measures; plots artillery and naval gunfire locations.

5. Regimental Air Officer (Regt AO). Coordinates air control measures with fire support measures; consolidates and prioritizes air requests from battalions; coordinates helicopter routes; monitors required communication nets; updates situation map and status boards.
6. Division Assistant Fire Support Coordinator (Div Asst FSC). Coordinates and consolidates all fire support coordination measures; coordinates the diversion of air missions based on target priorities; plots artillery and naval gunfire locations; coordinates the ATO with all fire support measures.
7. Division Air Officer (Div AO). Approves Regt AO recommended air control measures; consolidates and prioritizes preplanned air requests from the Regt AOs; monitors required communication nets; passes pertinent information to the Regt Aos; updates status boards; coordinates ATO with the FSC and DASC.

The one hundred and twenty-three (123) operators listed form the nucleus of the MACCS. The list does not include every MACCS operator. Also, in many cases, there is more than one operator of a given type within an agency. For example,

there is normally more than one communication operator in each agency, although, in several cases, only one is listed. The operator list was designed to represent the most significant operators in each agency, and to insure that each key operator was represented. With the operator listing established, the path listing must now be examined.

The second component of the CNA model is a listing of MACCS communication paths by which operators acquire information. The path listing contains ninety-three (93) communication paths determined to be the most common, and critical, used by MACCS operators. Again, just as with the operator listing, this path listing was not considered to be all inclusive. It was established to provide a framework from which the model could be established. The path listing will be presented here in three parts: first, a listing of paths not requiring radios; second, a listing of radio nets; and third, a listing of data links. No attempt will be made to explain the purpose or function of each path here for brevity's sake. The common abbreviation for each path is included in the listing for later use and reference.

The MACCS communication path listing is as follows:

PATH	ABBREVIATION
Non-radio	
Face to Face	FF
Intercom	INT
Local Hot Line	LOC HOT
Console Display	CON DIS

PATH	ABBREVIATION
Paper Message	PM
Status Board	SB
Tactical Telephone	TEL
Local Area Network	LAN
Radio nets	
ACE Command Net	ACE
ACE Tactical Air Command Net	TACmd
ACE Intelligence Net	ACE INTEL
ACE Fire Support Coordination Net	ACE FSC
ACE Communication Coordination Net	ACE COMM CORD
LAAM Battalion Command Net	LAAM BN Cmd
LAAD Battalion Command Net	LAAD BN Cmd
Command Action Net	CA
Air Operations Control Net (TACC-TAOC)	AOC-1
Air Operations Control Net (TAOC-EW/C)	AOC-2
Combat Information/Detection Net (TACC-TAOC)	CID-1
Combat Information/Detection Net (TAOC-EW/C)	CID-2
Voice Product Net	VPN
Handover Net	H/O
LAAD Weapons Control Net	LWCN
LAAD Team Control Net	LTCN
Interface Coordination Net	ICN
Track Supervision Net	TSN
Data-Link Coordination Net	DCN
Direct Air Support Net	DAS
Tactical Air Request/ Helicopter Request Net	TAR/HR
ASRT Control Net	ASRT CNTL
Tactical Air Control Party Local	TACP LOCAL
Tactical Air Traffic Control Net	TATC
Fighter Air Direction Net	FAD
Tactical Air Direction Net	TAD
Helicopter Direction Net	HD
Tanker Net	TANKER
Tactical Alert Net	TA
Squadron Common Net	SQD CMN
Group Common Net	GRP CMN
Tower Primary Net	TOWER
Tower Secondary Net	TOWER-2
Ground Control Net	GND
Approach Control Net	APP
Departure Control Net	DEP
Ground Control Approach Net	GCA
Guard	GUARD

PATH	ABBREVIATION
Crash, Fire, and Rescue Net	CFR
Search and Rescue Net	SAR
Air Traffic Control Common	ATC CMN
Air Base Security Net	AB SECURITY
Helicopter Landing Zone Control Net	LZ CNTL
Helicopter Landing Zone Control Team Local Net	LZ CNTL TM LOCAL
Med Bn Evacuation Coordination (Air)	EVAC COORD (AIR)
Med Bn Evacuation Coordination (Ground)	EVAC COORD (GND)
Landing Force Command Net	LF Cmd
Landing Force Tactical Net	LF TAC
Landing Force Intelligence Net	LF INTEL
Landing Force Combat Service Support Net	LF CSS
Landing Force Communication Coordination Net	LF COMM COORD
Infantry Battalion Tactical Net	BN TAC
Infantry Regiment Tactical Net	RGT TAC
Division Tactical Net	DIV TAC
Infantry Regiment Command Net	RGT CMD
Division Command Net	DIV CMD
Infantry Regiment Intelligence Net	RGT INTEL
Division Intelligence Net	DIV INTEL
Division Reconnaissance Net	DIV RECON
Division Air Observation Net	DIV AIR OBS
Artillery Battery Conduct Of Fire	BTRY COF
Artillery Battalion Conduct Of Fire	BN COF
Infantry Battalion Mortar Conduct Of Fire	BN MORTAR COF
Artillery Battalion Fire Direction	BN FD
Artillery regiment Fire Direction	RGT FD
Artillery Battalion Command Net	ARTY BN CMD
Artillery Regiment Command Net	ARTY RGT CMD
Artillery Regiment Tactical Net	ARTY RGT TAC
Artillery Regimet Survey/MET	SURVEY/MET
Artillery Air Spot Net	ARTY AIR SPOT
Infantry Regiment Fire Support Coordination Net	RGT FSC
Division Fire Support Coordination Net	DIV FSC
Shore Fire Control Party Local	SFCP LOCAL
Naval Gun Fire Air Spot Net	NGF AIR SPOT
Naval Gun Fire Ground Spot Net	NGF GND SPOT
Division Naval Gun Fire Support Net	DIV NGF SUPPORT
Division Radar Beacon	DIV RADAR BCN
Antiair Warfare Control and Reporting Net	AAWC/R

PATH	ABBREVIATION
Data Links	
Tactical Digital Information Link A	TADIL-A
Tactical Digital Information Link B	TADIL-B
Tactical Digital Information Link C	TADIL-C
Automated Tactical Data Link One	ATDL-1

Several of the paths on the list would not appear to be relavent to the Marine Air Command and Control System. Infantry and artillery nets are not an integral part of the MACCS. However, since much of the information needed by the MACCS is acquired from infantry and artillery sources, their paths were included in the modeling in order to determine the path interfacing between the MACCS and the Ground Combat Element.

The final listing required to complete the model is the information listing. One hundred and eighty-one (181) essential elements of information were identified as those necessary for the MACCS to successfully accomplish its mission. Just as with the operator and paths listings, no presentment was made by the CNA study that the information listing was all-inclusive. However, it was felt by the operators involved in the study that if these 181 information elements could be traced through the system, a significantly large sample of the system's model would be established to allow for analysis. The information elements were given no type of hierarchy or criticality rating. In other words, no

element of information was considered to have greater importance than another element. Although some information is certainly more important than other information, no hierarchy was considered for purposes of the model to preclude any controversy. The information listing, then, is in no particular order or sequence of importance.

The essential elements of information contained in the CNA model are:

Warnings and Conditions
1. Alert/Weapons Control Conditions
2. Emissions Control (EMCON) Status
3. Nuclear, Biological, and Chemical (NBC) Status
4. Air Raid Warning

Weather
5. Weather Report
6. Aviation Weather Report

ATO/Frag
7. ATO/Frag Distribution
8. ATO/Frag Update

ACE Concept of Operations
9. ACE Concept of Operations Update
10. Rules of Engagement (ROE) Update
11. HAWK Primary Target Line (PTL)/ Sector of Responsibility Update
12. COMM Plan
13. Deception Plan

GCE Concept of Operations
14. GCE Concept of Operations and Scheme of Manuever Update
15. Friendly Unit Locations
16. Target List
17. OAS/AS Target Prioritization Update
18. ASRT Immediate Targets

Personnel/Tasking
19. ACE Personnel Status
20. ACE Tasking
21. MAGTF Tasking

Equipment/Operational Status
22. Airfield/Forward Site Status

23. DASC Operational Status
24. ASRT Operational Status
25. GCE/Terminal Controller Operational Status
26. TACC COMM Status
27. TAOC Operational Status
28. TAOC COMM Status
29. TAOC Equipment Status Summary Report
30. HAWK Operational Status
31. HAWK Equipment/COMM Status Summary Report
32. LAAD Operational Status
33. MATCS Operational Status
34. External Control Agencies Operational Status

Agency Coordination
35. MACCS Agency Coordination
36. COMM Coordination
37. MACCS Agency Casualty Procedures
38. TAOC Reconfiguration
39. TACC Crew Configuration

Air Control Procedures
40. Change to Air Control Procedures-DASC or FSCC Generated
41. Change to Air Control Procedures-TACC Generated
42. Active Launch Routes/Recovery Changes
43. Remotely-Piloted Vehicle (RPV) Control Changes
44. Proposed Helicopter Route Coordination

Aircraft Check-in
45. FW RIO to DASC
46. RW RIO to DASC
47. Aircraft RIO to TACC
48. Aircraft Failure to RIO (FTR)

Mission Requests
49. Preplanned TAR/HR
50. On-call FW TAR
51. On-call RW OAS/AS Mission Request
52. On-call FW AAW Mission Request
53. On-call RW AAW Mission Request
54. Immediate FW TAR
55. Immediate RW OAS/AS Mission Request
56. Immediate FW AAW Mission Request
57. Immediate RW AAW Mission Request
58. Immediate TAR to Forward Site
59. Immediate ASR to Forward Arming and Refueling Point
60. GCE SEAD Request Response

Mission Changes
61. Change in FW OAS Mission Routing - Aircraft on Deck
62. Change in FW OAS Mission Routing - Aircraft Enroute
63. Change in FW OAS Mission Routing - at Forward Site (DASC Control)

64. Change in RW OAS/AS Mission Routing - Aircraft on Deck
65. Change in RW OAS/AS Mission Routing - Aircraft Enroute
66. Change in RW OAS/AS Mission Routing - At FARP (DASC Control)
67. GCE Approval of Aircraft Diverts

OAS/AS Mission Status

68. Pre-planned FW OAS Mission Status
69. TAR Status from FW Aircraft
70. TAR Status from FAC(A)
71. TAR Status from TACP/Requesting Unit
72. TAR Status from AO
73. TAR Status from DASC
74. TAR Status from TAC(A)
75. ASR Status from HC(A)/Helicopter
76. ASR Status from Requesting Unit
77. ASR Status from AO
78. ASR Status from DASC
79. ASR Status from TAC(A)
80. ASRT Mission Status
81. Status of Troop Lift

Aircraft Status

82. Status of FW OAS Aircraft under TACC Control
83. Status of RW OAS/AS Aircraft under TACC Control
84. Status of AAW Aircraft under TACC Control
85. Status of FW Aircraft under DASC Control
86. Status of RW Aircraft under DASC Control
87. Status of Forward-Sited Aviation Assets under TACC Control
88. Status of Forward-Sited Aviation Assets under DASC Control
89. Status of Strip Alert Aircraft (TACC Control)
90. Strip Alert Launch of FW OAS Aircraft
91. Strip Alert Launch of RW OAS/AS Aircraft
92. Strip Alert Launch of AAW Aircraft
93. Combat Air Patrol (CAP) Aircraft Status
94. Tanker Status
95. Aircraft Location

Air Defense Management

96. Sensor Management
97. Fighter Engagement Zone (FEZ) Status
98. Missile Engagement Zone (MEZ) Status
99. CAP Manning Scheme
100. Tanker Plan
101. Situational Awareness (SA) Update

AIr Threat Detections

102. HAWK Detections
103. LAAD Detections
104. TAOC and EW/C Detections

105. AAW Aircraft Detections
106. FW OAS Aircraft Detections
107. RW OAS/AS Aircraft Detections
108. GCE Detections
109. Detections from other Services

Track Management

110. Track Management - Friendly Known
111. Track Management - Hostile Known
112. Identification (ID) Classification Information (Info) from TAOC
113. ID/ Classification Info from HAWK
114. ID/Classification Info from Aircraft
115. Identification - Friend or Foe (IFF) Info
116. Data Link Management
117. Manual Crosstell Procedures
118. Manual Crosstell Execution

Fire Control Orders
119. AAW Target Prioritization Update
120. Aircraft Fire Control Order
121. HAWK Fire Control Order

Engagement Reports
122. AAW Aircraft Current Engagement Status
123. AAW Aircraft Engagement Summary Report
124. FW OAS Aircraft Current Engagement Status
125. FW OAS Aircraft Engagement Summary Report
126. RW OAS/AS Aircraft Current Engagement Status
127. RW OAS/AS Aircraft Engagement Summary Report
128. HAWK Current Engagement Status
129. HAWK Engagement Summary Report
130. LAAD Current Engagement Status
131. LAAD Engagement Summary Report

Intelligence/Combat Information
132. Intel Spot Report
133. Intel Report from GCE
134. Intel Summary (INTSUM)
135. Pilot Debriefs
136. FW OAS Pilot Reports and Combat Info
137. RW OAS/AS Pilot Reports and Combat Info
138. AAW Pilot Reports and Combat Info
139. Combat Info from HAWK
140. Combat Info from LAAD
141. Combat Info from GCE
142. Combat Info from RPV
143. Electronic Support Measures (ESM) Info
144. Threat Ground Force Info

Bomb Damage Assessment (BDA)
145. BDA from TACP/FAC(A)

146. BDA from AO
147. BDA from FW Aircraft
148. BDA from RW Aircraft
149. BDA from TAC(A)
150. BDA from Air Boss

Electronic Warfare (EW) Meaconing, Intrusion, Jamming, and Interference (MIJI) Reports

151. EW/FIR Report from AAW Aircraft
152. EW/FIR Report from FW OAS Aircraft
153. EW/FIR Report from RW OAS/AS Aircraft
154. EW/FIR Report from TAOC
155. EW/FIR Report from HAWK
156. EW/FIR Report from LAAD
157. EW/FIR Report from DASC
158. EW/FIR Report from GCE
159. MIJI Report from TAOC
160. MIJI Report from HAWK
161. MIJI Report from LAAD
162. MIJI Report from DASC
163. MIJI Report from GCE

SAW Movement

164. HAWK Movement Request
165. HAWK Movement Order
166. LAAD Movement Request
167. LAAD Movement Order

Fire Support Measures

168. Fire Support Coordination
169. Supporting Arms Info/Update

Logistics/Ordnance

170. Ground Supply
171. AMO Supply/Equipment Status
172. Ordnance Available
173. TAOC Logistics/Ordnance Resupply
174. HAWK Missile Inventory Report
175. HAWK Emergency Missile Resupply
176. HAWK Logistics/Administration (Admin) Info Request
177. HAWK Corrective Maintenance System (CMS) Info
178. HAWK Launcher Reload
179. LAAD Missile Inventory Report
180. LAAD Emergency Missile Resupply
181. LAAD Logistics/Admin Info/Request

These three listings: operators, paths, and information, form the foundation for the CNA model. Again, these listings were converted into diagrams showing the operators

with their primary paths to acquire needed information. The proposed method of analysis was to convert these diagrams based on the listings into a numeric data base for evaluation. Each operator's paths and information elements will be counted from the diagrams to determine how many of each the individual operator uses. Similiarly, each path will be looked at to determine how many operators are on each path, and how many information elements travel over each path. And finally, each information element will be looked at to determine how many operators use each information element, and to determine how many paths each element travels over. The numeric data base is presented in Appendix A. An analysis of the information exchange system, looking for anomalies and trends, will be conducted in Chapter 4 from this numerically established data base.

CHAPTER 4

ANALYSIS AND DISCUSSION

The conversion of the Center for Naval Analysis study diagrams into the numeric data base tables in Appendix A provides the vehicle to answer the thesis question -- Does information essential to the successful prosecution of the Marine Air Ground Task Force's air battle flow through the Marine Air Command and Control System in a timely, accurate, and efficient manner? The answer to this question is examined by looking at each of the tables independently, and then by looking at them collectively.

Caveats on the results of the diagram conversion are required. There was no presumption made by the operators at the working conference which developed the diagrams, nor by the Center for Naval Analysis who published the conference results, that the diagrams were complete, or perfect, in every way. They were a first attempt to quantify the flow of information within the Marine Air Command and Control System. Therefore, some results of the diagram conversion will reveal incongruities which may not exist, but are simply the product of a diagram being incomplete. The validity of identifying these incongruities should be couch-

ed in this context. However, their identification should at least assist in further refining and improving the model if they are in fact errors and not real system deficiencies.

A more severe caveat on the validity of the CNA information flow model concerns the information element listing. The absence of a criticality level being established for each information element is viewed as a significant flaw in the model. Some information will be more important than other information as the air battle unfolds, and will therefore take priority in being passed through the system. Yet the model reflects an equal importance in each information element, or at least does not make any distinction that one information element may be more important than another. In fairness, the operators who made the diagrams at the working conference were specifically instructed not to address the issue of information criticality. This does not obviate the flaw in the diagrams affecting any analysis conducted based on information for which no criticality has been established.

A final concern must be voiced concerning the manner in which the diagrams depict information flow. In many cases, one operator passes a single piece of information to a number of other operators over a common path. There is no way to determine from the diagrams whether this was a simultaneous transmission, or whether it was a sequential transmission to each operator individually. Because of this

lack of clarity in simultaneous versus sequential transmission, each was assumed in the numerical conversion to be an independent (sequential) event. If they were in fact simultaneous, some of the data reflected in Appendix A is skewed. However, since the purpose of the conversion of the diagrams to a numeric data base was to conduct a gross number analysis of the system's performance, this potential skewing of some data elements is not believed to significantly detract from the validity of the analysis of the total gross numbers.

The operator tables (Tables A-1 and A-2 in Appendix A) were examined first. Table A-1 provides the total number of mediums or paths used by each operator to acquire or exchange information. The average number of paths used by each operator was 3.3 paths per operator. The largest number of paths used by a single operator was 8 (both by Aircrew and the TAOC SAD). The smallest number of paths used by a single operator was 1 (found to be the case with 22 operators). These operators with only 1 path are questionable considering all of the paths (as in Face-to-Face, Intercom, or Paper Message) which operators routinely use. For purposes of further correlation, the operators with the most paths are listed (in order of most paths used):

Listing 1

Operators versus Paths

1. Aircrew - 8

Listing 1 (Cont.)

2. TAOC SAD - 8
3. TACC ADC - 7
4. TAOC SO - 7
5. SAAWC Ops - 7
6. RGT FSC - 7
7. ACE G-2 Officer - 6
8. ACE G-3 Ops Officer - 6
9. MAG S-3 Officer - 6
10. TACC ASC - 6
11. TACC ICO - 6
12. TACC TDC - 6
13. TACC IWO - 6
14. TAOC TDC - 6
15. TAOC TATC - 6
16. TAOC MC - 6
17. EW/C Dir - 6
18. SAWWC SAW Rep - 6
19. HAWK BN CP Comm Op - 6

Of these top 19 operators using the most paths, five are from the TACC, five are from the TAOC, and four are from the ACE. These facts will be correlated with other tabular data later.

Table A-2 provides the total number of information elements either needed by each operator, or the information elements each operator was required to exchange. The aver-

age number of information elements used by each operator was 46. The largest number of information elements used by a single operator was 134 (TACC SAC). The smallest number of information elements used was 1 (found with the ACE G-1 Officer, MAG S-1 Officer, MAG S-3 WEO, SQDN S-1 Officer, and HAWK PCP Operator). Thirty-eight operators used 15 or fewer information elements. For purposes of further correlation, the operators using or exchanging the most information elements are listed (in order of information elements used):

Listing 2

Operators versus Information

1. TACC SAC - 134
2. DASC SAD - 126
3. DASC CC - 126
4. TACC ASC - 123
5. TACC Plotter - 114
6. Div Asst FSC - 102
7. Regt FSC - 100
8. TAOC SAD - 99
9. SAAWC Ops - 98
10. TACC TAC - 96
11. Div AO - 94
12. TACC ADC - 94
13. Regt AO - 92
14. SAAWC - 91
15. DASC HD - 91

Listing 2 (Cont.)

16. DASC DAS - 91

17. DASC TAD - 90

Of these top 17 operators of information elements used, five were from the TACC, five were from the DASC, and four were from thr FSCC. These facts will be correlated with other tabular data later.

The medium/path tables (Tables A-3 and A-4) were examined next. Table A-3 provides the total number of operators which used each medium or path. The average number of operators using each of the paths was 9. The largest number of operators using a single medium or path was 94 (Face-to-Face). The smallest number of operators using a single medium or path was 1 (found with CID-3, VPN, ICN, DCN, ACN, TACP LOCAL, LF Cmd, LF TAC, and LF INTEL). Forty-five of the ninety-two listed paths were not used at all in the diagrams. This does not necessarily mean that no information is exchanged over them. It may be that either they were overlooked, or that information not included in this information list are exchanged over them. For purposes of the rest of this discussion, only the forty-seven paths actually used in the model will be addressed. The mediums or paths with the largest number of operators using them are listed (in order of the path having the most operators using it):

Listing 3

Paths versus Operators

1. Face-to-Face (FF) - 94
2. Paper Message (PM) - 65
3. Intercom (INT) - 54
4. Status Board (SB) - 41
5. Telephone (TEL) - 24
6. Local Area Network (LAN) - 16
7. ACE Tactical Air Command (TACmd) - 11
8. Console Display (CON DIS) - 10
9. AntiAircraft Control (AAC) - 10
10. AntiAircraft Intelligence (AAI) - 8
11. ACE Intelligence (ACE INTEL) - 7
12. Tactical Alert (TA) - 7
13. LAAD Command Net (LCN) - 5
14. Tactical Air Traffic Control (TATC) - 5

It is interesting to note at this point that the most common means of exchanging information in this automated system model is predominately by face-to-face communication between operators, followed by information on paper messages and over intercom systems. This information will be correlated with other tabular data later.

Table A-4 provides the total number of information elements which are conveyed over each medium or path. The average number of information elements on each medium or path was 43. Of the 92 mediums/paths listed, 44 had no informa-

tion conveyed over them. The medium/path with the largest number of information elements conveyed was Face-to-Face (FF) with 167. The path with the smallest number of information elements was a tie between Voice Product Net (VPN) and Data Link Coordination Net (DCN) with 1 each. The mediums or paths with the most information elements conveyed over them are listed (in order of most information elements conveyed):

Listing 4

Paths versus Information

1. Face-to-Face (FF) - 167
2. Intercom (INT) - 163
3. Paper Message (PM) - 154
4. Telephone (TEL) - 133
5. Local Area Network (LAN) - 123
6. Direct Air Support (DAS) - 88
7. ACE Tactical Air Command (TACmd) - 77
8. Tactical Air Traffic Control (TATC) - 76
9. ASRT Control Net (ACN) - 75
10. Status Board (SB) - 68
11. Tactical Air Request/Helicopter Request (TAR/HR) - 66
12. Division Fire Support Coordination (Div FSC) - 63
13. Tactical Air Direction (TAD) - 56
14. Helicopter Direction (HD) - 56

Listing 4 (Cont.)

15. Regimental Fire Support Coordination (Regt FSC) - 54
16. Air Operation Control-2 (AOC-2) - 48
17. Handover (H/O) - 45
18. Fighter Air Direction (FAD) - 44

Again, it is interesting to note that the most information is conveyed by face-to-face, by intercom, and by paper messages. This information will be compared to other tabular data later.

The final two tables analyzed (Tables A-5 and A-6) were the information tables. Table A-5 provides the total number of operators who acquired or exchanged each information element. The average number of operators exchanging each information element was 33. The largest number of operators exchanging a single piece of information was 86 (an eight-way tie between information elements 136-143). The smallest number of operators exchanging a single piece of information was 2 (information element 8. Aviation Weather). The information elements having the most operators involved in exchanging them are listed (in order of most operators involved):

Listing 5

Information versus Operators

1. 136. FW OAS Info - 86
2. 137. RW OAS Info - 86

Listing 5 (Cont.)

3. 138. AAW A/C Info - 86
4. 139. HAWK Info - 86
5. 140. LAAD Info - 86
6. 141. GCE Info - 86
7. 142. RPV Info - 86
8. 143. ESM Info - 86
9. 132. Intel Spot Report - 84
10. 133. GCE Intel Report - 84
11. 2. EMCON Status - 83
12. 3. NBC Status - 81
13. 134. INTSUM - 81
14. 40. ACP Changes (DASC/FSCC) - 72
15. 41. ACP Changes (TACC) - 70
16. 10. ROE Update - 65
17. 102. HAWK Detections - 65
18. 103. LAAD Detections - 65
19. 104. TAOC Detections - 65

This listing establishes a framework for further discussion on which information is most commonly required or exchanged between system operators. It should not be construed to indicate which information is most important. The final table now needed evaluation.

Table A-6 provides the total number of mediums or paths over which each information element was exchanged. The average number of paths each information element was exchanged

was 12. The largest number of paths each single information element was exchanged over was 33 (information element 138. AAW A/C Info). The smallest number of paths a single information element was exchanged over was 2 (information element 178. HAWK Reload). The information elements which were exchanged over the most paths are listed (in order of most paths used):

Listing 6

Information versus Paths

1. 138. AAW A/C Info - 33
2. 139. HAWK Info - 32
3. 109. Detection from Other Services - 28
4. 102. HAWK Detections - 27
5. 103. LAAD Detections - 27
6. 104. TAOC Detections - 27
7. 105. AAW A/C Detections - 27
8. 106. FW OAS Detections - 27
9. 107. RW OAS Detections - 27
10. 108. GCE Detections - 27
11. 136. FW OAS Info - 27
12. 137. RW OAS Info - 27
13. 140. LAAD Info - 27
14. 141. GCE Info - 27
15. 142. RPV Info - 27
16. 143. ESM Info - 27
17. 1. Alert/Weapon Control Conditions - 22

18. 40. ACP Changes (DASC/FSCC) - 22

19. 41. ACP Changes (TACC) - 22

20. 132. Intel Spot Report - 22

This listing shows the volume of different paths over which information elements must pass for each element to reach its operator. With the six tables now broken into more manageable listings, a more detailed evaluation of system performance was possible.

What is the relavence of these listings to the thesis question? Timeliness, efficiency, and accuracy of information exchange had to be addressed. Timeliness could only be addressed qualitatively. If a piece of information was acquired by its passage between two operators over a single path, it would be acquired in an optimally timely fashion. On the other hand, if a piece of information was acquired by an operator after having passed over multiple paths through several operators, it would be acquired by the terminal operator in a much less timely manner. Timeliness evaluation, then, will be based on the number of different operators a single element of information must pass through, and the number of paths it must transit. Only the most frequently used information was evaluated for brevity's sake, but as the information used by the most operators it should provide some insight in to relative timeliness of information exchange.

The nineteen information elements which had the highest operator applicability were examined. Each information element was re-examined to determine the number of paths over which each transitted. Their relative ranking for timeliness was based on the fewer paths used to exchange the information, the more timely all of the operators should acquire the information. This was a subjective determination, but was based on practical experience which has shown that the greater the number of paths information is exchanged over, the less timely it is acquired by all operators. The relative timeliness listing of the nineteen most used information elements, with the number of paths each transits, the number of operators which use the information, and its ranking of use is:

Listing 7

Timeliness

Information	# of Paths	# of Operators	Use Rank
1. 2. EMCON	15	83	11
2. 10. ROE	18	65	16
3. 3. NBC	19	81	12
4. 134. INTSUM	19	81	13
5. 133. GCE INT	21	84	10
6. 132. Intel S	22	84	9
7. 40. ACP Chang	22	72	14
8. 41. ACP Chang	22	70	15
9. 136. FW OAS	27	86	1

Listing 7 (Cont.)

10.	137.	RW OAS	27	86	2
11.	140.	LAAD In	27	86	5
12.	141.	GCE In	27	86	6
13.	142.	RPV In	27	86	7
14.	143.	ESM In	27	86	8
15.	102.	HAWK D	27	65	17
16.	103.	LAAD D	27	65	18
17.	104.	LAAD D	27	65	19
18.	139.	HAWK In	32	86	4
19.	138.	AAW A/C	33	86	3

With the number of paths used for information exchange as the timeliness criteria, it was fascinating to find that of the information used by the most operators, the most timely information transitted fifteen different paths, while the least timely transitted thirty-three paths. Any information exchange system which uses this number of paths to provide the most commonly needed information appears to be seriously flawed. It would seem reasonable to state that the information needed by 86 operators transitting 33 different paths would not be acquired by each operator in as timely a fashion as possible. The absence of a system design or architecture would certainly appear to have adversely affected the timely exchange of information within the criteria established.

The second component of the thesis question was concerned with the efficiency of information exchange. Eff-

iciency was evaluated from two aspects -- first, from an operator use viewpoint, and second, from a path use viewpoint. Efficiency from the operator use viewpoint could have been considered from a number of approaches. Efficiency for information responsibility could have been set where a single operator at each agency was responsible for a single piece of information. Though this would have been efficient information management, it would have been terrible operator utilization. Similiarly, a single dedicated path for each operator and his information might have ensured efficient information transit, but was unrealistic for existing system capabilities. Efficiency evaluation relative to operator use was established based on the volume of information each was responsible for, and the number of paths each used to exchange information. Efficiency was rated as a function of the information volume divided by the paths utilized. The higher the resulting number, the more efficient each operator was determined to be. There is a serious danger with this evaluation. There is a limit to the number of paths a single operator can use simultaneously, just as there is a limit to the amount of information a single operator can process simultaneously. Human factors limitations were not addressed in the evaluation, but should certainly be considered as an important limitation on the information system's performance. The results of the operator efficiency evaluation, using the seventeen operators exchanging the most information, are (in order of efficiency):

Listing 8

Operator Efficiency

Operator	# of Info	# of Paths	Efficiency
1. Regt AO	92	1	92.0
2. TACC Plotter	114	2	57.0
3. DASC CC	126	3	42.0
4. TACC SAC	134	4	33.5
5. TACC TAC	96	3	32.0
6. DASC SAD	126	4	31.5
7. Div Asst FSC	102	4	25.5
8. DASC DAS	91	4	22.7
9. TACC ASC	123	6	20.5
10. SAAWC	91	5	18.2
11. DASC HD	91	5	18.2
12. DASC TAD	90	5	18.0
13. Regt FSC	100	7	14.3
14. SAAWC Ops	98	7	14.0
15. TACC ADC	94	7	13.4
16. TAOC SAD	99	8	12.4
17. Div AO	94	8	11.8

This operator efficiency listing provides the average number of information elements per path used by the operators exchanging the largest volume of information. From Table A-2 the average number of information elements used by each operator was 46. From Table A-1 the average number of paths used by each operator was 3.3 per operator. The average

system efficiency, then, would be 13.9 (46/3.3). This means that only fourteen out of one hundred thirty-one operators equal or exceed the average system efficiency. If exchanging the maximum amount of information over the fewest possible number of paths is a determinant of system efficiency, then a system which has over 90% of its operators below the average system efficiency is probably of questionable efficiency from an operator perspective.

The second evaluation criteria examined to determine system efficiency was path use. As stated above, an efficient system would be designed to process the maximum amount of information over the fewest possible number of paths, with the largest number of operators acquiring information over the fewest paths possible. The paths carrying the most information elements were examined compared to the operators using the paths to determine an efficiency baseline. The paths are listed in order of efficiency determined by dividing the number of information elements on each path by the number of operators which use each path. The path efficiency list is:

Listing 9

Path Efficiency

Path	# of Info Elements	# of Operators	Eff
1. SB	68	41	1.7
2. FF	167	94	1.8
3. PM	154	65	2.4

Listing 9(Cont.)

4. INT	163	54	3.0
5. TEL	133	24	5.6
6. TACmd	77	11	7.0
7. LAN	123	16	12.0
8. H/O	45	3	15.0
9. TATC	76	5	15.2
10. HD	56	3	18.7
11. TAD	56	3	18.7
12. FAD	44	2	22.0
13. AOC-2	48	2	24.0
14. Regt FSC	54	2	27.0
15. Div FSC	63	2	31.5
16. TAR/HR	66	2	33.0
17. ACN	75	2	37.5
18. DAS	88	2	44.0

The system path efficiency average was computed from the average number of information elements per path (43) divided by the average number of operators using each path (9) as 4.8. 90+% of the system's paths exceeds this average. It is worth noting again that the majority of the paths which are more efficient than the system average are the most basic forms of communication - face-to-face, paper messages, intercom, etc. If the reverse of this criteria of path efficiency was used, the system would certainly appear much more efficient. However, the logical extension

of the rationale of maximum information on a path with minimum instead of maximum operators would lead to a system requirement to increase the number of paths by quantum factors to optimize system efficiency. The criteria evaluated, though bringing into question the existing system's path efficiency, could provide a guide for system improvement by looking for ways to increase operator use of existing paths.

For purposes of the thesis question, then, after separately evaluating both the efficiency of system operators and system paths as identified in the CNA model, the conclusion would have to be that the system is less than optimally efficient. The evaluations provide a basis from which improvements in system efficiency could be instituted.

The final component of the thesis question concerned the accuracy of information exchanged by the system. Information accuracy was again a qualitative judgement based on the evaluation of the reduced model data. The old example of information being distorted by telling a story to one person, who repeats it through a chain of people until the final person re-tells the story in a totally distorted form, was applied to the model. Criteria for accuracy was established by determining that the fewest number of operators to be involved in exchanging an information element would increase the accuracy of the information. Conversely, the greater the number of operators involved in exchanging a

given piece of information, the greater the probability of the information being inaccurate. Included in the accuracy evaluation were the number of different paths a piece of information would have to transit to its destination. The fewer the number of paths involved, the greater the probability of the information being accurate. The most commonly used information elements were evaluated, and are listed in order of accuracy (smallest sum of operators and paths):

Listing 10

Information Accuracy

Information	# of Operators	# of Paths	Accuracy
1. 10. ROE	65	18	83
2. 41. ACP	70	22	92
3. 102. HAWK	65	27	92
4. 103. LAAD	65	27	92
5. 104. TAOC	65	27	92
6. 40. ACP	72	22	94
7. 2. EMCON	83	15	98
8. 3. NBC	81	19	100
9. 134. INTSUM	81	19	100
10. 133. GCE	84	21	105
11. 132. Intel	84	22	106
12. 136. FW OAS	86	27	113
13. 137. RW OAS	86	27	113
14. 140. LAAD	86	27	113
15. 141. GCE	86	27	113

Listing 10 (Cont.)

16.	142. RPV	86	27	113
17.	143. ESM	86	27	113
18.	139. HAWK	86	32	118
19.	138. AAW A/C	86	33	119

The most accurate possible information exchange system would have two operators connected by one path. In terms of this accuracy criteria, it would have an accuracy of 3. This should put into perspective the potential for inaccuracy in a system with accuracy factors of from 83 to 119 on the most commonly exchanged information in the system. The average system accuracy factor would be 45 (averaging 33 operators and 12 paths per information element). Certainly information can be exchanged accurately with more than two operators and one path involved. But remembering that the majority of the 181 information elements are exchanged at some point by face-to-face, intercom, or paper message, the accuracy of the information after it has passed through from 45 (on average) up to 86 operators can certainly be questioned.

An answer to the thesis question was decided. The Marine Air Command and Control System could potentially exchange any one given information element in a timely, efficient, and accurate manner. However, in a high intensity environment where the majority if not all information elements would be required to be passed or updated contin-

uously and simultaneously, it is highly questionable, if not physically impossible, for the Marine Air Command and Control System (as identified in the CNA model) to exchange information in a timely, efficient, and accurate manner.

CHAPTER 5

RECOMMENDATIONS

The criticality of effective information flow within the Marine Air Command and Control System (MACCS) cannot be over-emphasized. The rapid tempo of air operations on the modern battlefield mean decisions must be made by commanders and their staffs in an equally rapid manner. Timely, efficient, and accurate information is essential if correct decisions are to be made. Upon completing this analysis, there is serious doubt whether the MACCS as currently designed will be capable of meeting its information flow responsibilities. In fairness, it must be remembered that the MACCS was never really designed -- that is, it is a system which evolved over many years with no specific system requirements, design, or architecture ever clearly established. It can, and has, operated for many years in low tempo environments where the entire system has not been required to simultaneously process and exchange large volumes of critical information. When high volume demands have been placed rapidly upon it, the system has traditionally experienced difficulties, if not outright failure. This has traditionally been attributed to inexperienced operators

or equipment difficiencies, when in fact the system itself was never truly designed to perform at this level. A solution to the problem is possible. The following recommendations can provide a Marine Air Command and Control System capable of providing timely, efficient, and accurate information flow in a high tempo air battle.

The first recommendation to improve the MACCS is the establishment of a Required Operational Capability (ROC) for the Marine Air Command and Control System. A ROC is the baseline document which established a need for a capability, and outlines the operating characteristics of the capability required. This document for the first time would address what the MACCS is really supposed to be capable of doing. ROCs exist, and have existed, for component agencies of the MACCS, but never for the system as a whole. The establishment of a Required Operational Capability for the MACCS would provide the critical first step toward formalizing the capabilities and architecture for the MACCS, attacking the issue from a system approach instead of the piece-meal, component approach of the past.

The second recommendation is to develop a Concept of Emploment (COE) for the Marine Air Command and Control System. A Concept of Employment takes the system identified in the ROC and addresses how it would be employed in combat. In the COE, issues concerning system employment in low, mid, and high intensity conflicts would be addressed. Over the

horizon operations, and the system's employment in them, would be addressed. Critically, the COE would provide the framework from which issues concerning system operators, paths, and information would start to evolve. The supporting framework of the system needed to provide the capability identified in the ROC and to meet the employment criteria in the COE should begin to crystalize.

While the first two recommendations are being implemented, work on formalizing the structure of the existing system should continue. The good things about the existing system should be identified, and planned for implementation in the follow-on system. Throwing the baby out with the wash is not the objective here. The MACCS works today because many things in it are timely, efficient, and accurate. By continuing to refine and update the system model in the CNA study, improvements in the performance of the existing system are certainly possible, and a more complete picture of system potential would be available for follow-on system development. The third recommendation, then, is continued work on completing, correcting, and updating on a continuing basis the modeling efforts started in the CNA study.

As a culmination of the three recommendations presented, a formal architecture for the Marine Air Command and Control System should be developed. The architecture would be designed to meet the capabilities identified in the ROC

and the employment requirements identified in the COE, and provided in the format of the CNA study. This detailed level of a formal architecture would force the developers to justify the need for and performance tasks of each operator within the system, the need for and use of every path within the system, and the information which the system must be capable of exchanging in a timely, efficient, and accurate manner. Personnel issues such as manning and training would then be formalized by the systems requirements, not by the current system of supposition on system needs. Equipment capable of providing efficient paths could be more readily identified, and developed and procured with the objective of providing the minimum number of paths serving the maximum number of operators with timely, efficient, and accurate information. Sources and forms of information could be better quantified; and sensors, display media, and automated data bases capable of rapidly processing and displaying large quantities of information could be designed to replace the system's current reliance on status boards and paper messages to exchange a great majority of information. A formal architecture of the Marine Air Command and Control system is essential if it is in fact going to be an information exchange system, and not a grouping of independent components working often to cross-purposes.

This analysis was an effort to quantify and identify the performance capability of the Marine Air Command and

Control system as an information exchange system. The results have identified some serious questions about the system's ability to process large volumes of information in high tempo operations. Implementation of the four recommendations above should provide a Marine Air Command and Control System far superior in capability to the system as it exists today. The methodical basis of system development provided by a Required Operational Capability (ROC), a Concept of Employment (COE), a continued study and analysis of the current MACCS, and the formalization of the information exchange architecture, should provide the Marine Air Ground Task Force commander of the future with a Marine Air Command and Control System which is flexible, responsive, and capable of performing all required missions in conflicts of any intensity. This objective is worth the effort required.

On the recommendation of the Academic Advisor for this thesis, a draft of the thesis was provided to selected individuals knowledgeable in the Marine Air Command and Control System for comment. Their comments and perspectives on the issues addressed by the thesis are included in Appendix B.

APPENDIX A

APPENDIX A

INFORMATION FLOW DATA BASE

The Center for Naval Analysis C3 Information Flow Model established the parameters of a Marine Air Command and Control System (MACCS) model in terms of operators, mediums/paths, and critical information elements. The reduction of these parameters into data tables should reveal answers to questions of how efficiently the MACCS exchanges information.

The diagrams of the CNA model have been reduced into six tables. Table A-1 lists the system's operators showing which mediums/paths each operator accesses and the total number of paths each operator uses. Table A-2 lists the system's operators and the information elements each operator is responsible for or requires. Table A-3 lists the mediums or paths used by the system and the operators which use each path, including the total number of operators using each path. Table A-4 lists the mediums or paths and the information elements which transit each path, with the total number of information elements on each path indicated. Table A-5 lists the information elements used by the system and the operators which use each information element, with the total number of operators using each element indicated. Table A-6 lists the

information elements with the paths over which each element is transmitted, and the total number of paths over which each element is transmitted indicated. All tables use abbreviations identified in Chapter 3. These abbreviations are used for brevity's sake since the volume of data portrayed without abbreviation was simply to large to manipulate. Operators names are abbreviated using the common short titles used by MACCS operators. Mediums/paths use the common abbreviations identified in Chapter 3. Information elements are referred to by the number where they appear on the CNA information list identified in Chapter 3. The analysis of the reduced data portrayed in the tables is discussed in Chapter 4.

TABLE A-1

OPERATORS VERSUS MEDIUMS/PATHS

Operators	Mediums/Paths	Total
ACE Crew Positions		
ACE Headquarters		
G-1 Officer	FF,PM,SB	3
G-2 Officer	FF,PM,SB,TEL,ACE INTEL,LF INTEL	6
G-3 Officer	FF,PM,TA,LF CMD,LF TAC	5
G-3 Ops Officer	FF,PM,SB,TEL,LAN,TA	6
G-3 FW/RW Fragger	PM,TEL,LAN	3
G-3 WEO	FF	1
G-3 ACO	FF,PM,SB,TEL	4
G-3 C3CMO	FF,TEL	2
Comm Elec Officer	FF,PM	2
G-4 Officer	FF,PM,TEL,ACE CSS	4
Ordnance Officer	FF,PM	2
AMO	FF,PM	2
MAG Headquarters		
S-1 Officer	FF,PM,SB	3
S-2 Officer	FF,PM,ACE INTEL	3
S-3 Officer	FF,PM,SB,TEL,LAN,TA	6
S-3 Plans Officer	FF,PM	2
S-3 Fragger	FF,PM,SB,TEL	4
S-3 WEO	FF	1
S-4 Officer	FF,PM	2
Ordnance Officer	FF,PM	2
AMO	FF,PM,SB	3
Squadron Headquarters		
S-1 Officer	FF,PM,SB	3
S-2 Officer	FF,PM,ACE INTEL	3
S-3 Officer	FF,PM,SB,TEL,TA	5
Flight Officer	PM	1
WTI	FF	1
ODO	FF,PM,SB,TEL	4
S-4 Officer	FF,PM	2
Ordnance Officer	FF,PM,SB,TEL,LAN	5
AMO	FF,PM	2
Aircrew	FF,PM,SB,SQD CMN,TATC,FAD,TAD,HD	8
TACC		
TAC	FF,INT,PM	3
SAC	FF,INT,PM,LAN	4

Operators	Mediums/Paths	Total
ADC	INT,PM,SB,TACmd,CA,AOC-1,TA	7
ADR	INT,PM	2
ASC	FF,INT,PM,TACmd,DAS,TA	6
ASR	PM,SB,TACmd	3
ICO	FF,INT,PM,ICN,TSN,DCN	6
TDC	INT,PM,VPN,TSN,TADIL-A,TADIL-B	6
TAWO	FF,INT,TEL,LAN	4
ASWO	FF,INT,TEL,LAN,TACmd	5
IWO	FF,PM,SB,TEL,LAN,ACE INTEL	6
CC	FF,INT,TEL,LAN	4
MC	FF,INT,TEL,LAN	4
Plotter	INT,PM	2
G-3 WO	FF,TEL,LAN,	3
ACO	INT,PM,SB	3
Air Boss	TEL,LAN	2
TAOC		
SAD	INT,LOC HOT,CON DIS,PM,SB,CA,AOC-2, CID-2	8
CC	FF,INT,PM,TEL	4
Plotter A	FF,INT,PM,SB	4
Plotter B	FF,SB	2
Plotter C	FF,SB	2
SID	INT,LOC HOT,CON DIS,PM,SB	5
TDC	INT,CON DIS,SB,TSN,TADIL-A,TADIL-B	6
SO	INT,CON DIS,SB,CID-2,CID-3,AAI,ATDL	7
ECCM Op	LOC HOT	1
STD	INT,CON DIS,PM,SB,H/O	5
TATC	INT,CON DIS,PM,SB,H/O,TATC	6
SWD	INT,CON DIS,PM,SB	4
AIC	INT,CON DIS,SB,FAD,TADIL C	5
MC	INT,CON DIS,SB,AAC,AAI,ATDL	6
AWC	INT,CON DIS,SB	3
EW/C		
EW/C Dir	INT,LOC HOT,PM,SB,AOC-2,CID-2	6
SO	INT,SB,CID-2	3
TATC	INT,SB	2
AIC	INT,SB	2
MC	INT,SB	2
AWC	INT,SB	2
ECCM Op	LOC HOT	1
SAWWC Crew		
SAAWC	FF,INT,SB,TACmd,TA	5
SAAWC Ops	FF,INT,SB,LAN,TACmd,CA,AOC-1	7
CC	FF,TEL,LAN	3

Operators	Mediums/Paths	Total
S-2 Officer	INT,SB,ACE INTEL	3
SAW Rep *	FF,INT,SB,TEL,TACmd,LCN	6
HAWK Crew Positions		
BN CP		
S-1 Officer	FF	1
S-2 Officer	FF	1
S-3 Officer	FF,INT	2
TD	FF,AAC,AAI	3
Ops Assistant	FF,INT,AAC	3
Journal Recorder	FF,INT	2
NBC NCO	FF	1
Comm Operators	FF,PM,TEL,ACE INTEL,TACmd,LAAM BN Cmd	6
Plotter	FF,SB,AAC,AAI	4
LAAD Rep	TEL,TACmd,LCN,AAC,AAI	5
S-4 Officer	FF	1
HAWK BFU		
TCO	FF,INT,AAC,ATDL	4
TCA	FF,INT,AAI	3
ASO	FF	1
FCO	INT	1
HAWK AFU		
TO	FF,INT,AAC,ATDL	4
RO	FF,AAI	2
PCP Operator	FF	1
COC,BFU or AFU		
OIC	FF,INT	2
Comm Operator	FF,TEL,LAAM BN Cmd	3
Recorder/Plotter	AAC,AAI	2
GD NCOIC	FF	1
NBC NCOIC	FF	1
LAAD Rep	AAC,AAI	2
LAAD Crew		
BIC		
OIC	FF,TEL,TACmd,LCN,AAC	5
Admin/Log	FF	1
Asset Plotter	FF	1
Track Plotter	FF,LCN,AAI	3
LAAD Platoons		
Platoon Cmdr	LCN,LWCN	2
Section Leader	FF,PM	2
Section Comm Op	FF,PM,LWCN,LTCN	4
Team Leader	FF,LTCN	2

* Included on CNA diagram, but not on list

Operators	Mediums/Paths	Total
DASC Crew		
SAD	FF, INT, PM, LAN	4
TAD	FF, INT, PM, TATC, TAD	5
HD	FF, INT, PM, TATC, HD	5
CC	FF, INT, PM	3
TAR/HR	FF, INT, PM, TAR/HR	4
DAS	FF, INT, PM, DAS	4
TAC	FF, INT, PM, TACmd	4
ACN	FF, INT, PM, H/O, ACN	5
Plotter	FF, INT, PM, SB	4
TAC(A) *	TATC, TAD	2
HC(A) *	TATC, HD	2
LAAD Rep *	FF, INT, TEL, TACmd	4
Intel O *	FF, INT, PM, ACE INTEL	4
FSCC Crew		
TACP/FAC	TAR/HR, TACP LOCAL	2
Bn FSC	FF, PM, RGT TAC, RGT FSC	4
Bn AO	FF	1
Regt FSC	FF, PM, LAN, DIV TAC, RGT TAC, DIV FSC, RGT FSC	7
Regt AO	FF	1
Div ASST FSC	FF, PM, DIV TAC, DIV FSC	4
Div AO	FF, LAN	2
Bn S-3 *	FF	1
Regt S-3 *	FF	1
Div G-3 *	FF	1

*Included on CNA diagram, but not included on list

TABLE A-2

OPERATORS VERSUS INFORMATION

Operators	Information Elements	Total
ACE Crew Positions		
ACE Headquarters		
G-1 Officer	19	1
G-2 Officer	2,5,14,17,18,38,102,103,104,105,106, 107,108,109,111,123,125,127,129,131, 132,133,134,135,136,137,138,139,140, 141,142,143,144,145,146,147,148,149, 150	39
G-3 Officer	1,3,5,7,9,10,12,13,14,19,21,40,41,95, 123,125,127,129,131,132,133,134,136, 137,138,139,140,141,142,143,144,145, 146,147,148,149,150,172	38
G-3 Ops Officer	1,2,3,7,14,21,22,23,24,25,27,29,30, 31,32,33,34,40,41,44,49,95,102,103, 104,105,106,107,108,109,111,123,125, 127,129,131,132,133,134,136,137,138, 139,140,141,142,143,144,145,146,147, 149,150,172,173,175,176,180,181	59
G-3 Plans Officer	5,21,135,136,137,138,139,140,141,142, 143,172	12
G-3 FW/RW Fragger	5,7,8,13,20,21,44,49,95,132,133,134, 172	13
G-3 WEO	145,146,147,148,149,150,172	7
G-3 ACO	2,22,23,24,27,29,30,31,32,33,34	11
G-3 C3CMO	2,12	2
Comm Elec Officer	2,12,13,19,36	5
G-4 Officer	2,170,173,175,176,180,181	7
Ordnance Officer	19,21,171,172,173,175,176,180,181	9
AMO	19,21,171	3

Operators	Information Elements	Total
MAG Headquarters		
S-1 Officer	19	1
S-2 Officer	5,102,103,104,105,106,107,108,109, 111,123,125,127,129,131,132,133,134, 135,136,137,138,139,140,141,142,143, 144,145,146,147,148,149,150	34
S-3 Officer	1,2,3,5,7,8,9,10,12,13,14,20,22,23, 24,25,27,29,30,31,32,33,34,40,41,82, 83,84,85,86,87,88,89,93,95,123,125, 127,129,1131,132,133,134,135,136,137, 138,139,140,141,142,143,144,145,146 147,148,149,150,172,177	61
S-3 Plans Officer	5,20,172	3
S-3 Fragger	7,20,95,172	4
S-3 WEO	172	1
S-4 Officer	18,170,173,175,176,180,181	7
Ordnance Officer	19,171,172,173,175,176,180,181	8
AMO	2,171	2
Squadron Headquarters		
S-1 Officer	19	1
S-2 Officer	5,7,14,102,103,104,105,106,107,108, 109,132,133,134,135,136,137,138,139, 140,141,142,143,144,145,146,147,148, 149,150	30
S-3 Officer	1,2,3,6,7,8,20,23,24,25,27,29,30,31, 32,33,34,40,41,95,132,133,134,135, 136,137,138,139,140,141,142,143,144, 145,146,147,148,149,150,172	40
Flight Officer	7,20,172	3
WTI	20,132,133,134,136,137,138,139,140, 141,142,143,144,172	14
ODO	1,2,3,6,7,8,20,23,24,25,27,29,30,31,	33

Operators	Information Elements	Total
	32,33,34,40,41,95,132,133,134,136, 137,138,139,140,141,142,143,144,172	
S-4 Officer	19,170,173,175,176,180,181	7
Ordnance Officer	2,7,19,171,172,173,175,176,180,181	10
AMO	5,7,19,171	4
Aircrew	1,2,3,6,7,8,9,10,12,14,20,22,23,24, 25,27,29,30,31,32,33,34,40,41,95,132, 133,134,135,136,137,138,139,140,141, 142,143,144,145,146,147,148,149,150	44
TACC Crew		
TAC	1,2,3,4,8,9,10,12,13,14,17,18,22,35, 37,38,39,40,41,43,50,51,52,53,54,55, 56,57,58,59,60,61,62,63,64,65,66,82, 83,84,85,86,87,88,89,90,91,92,93,102, 103,104,105,106,107,108,109,117,118, 122,124,126,128,130,132,133,134,136, 137,138,139,140,141,142,143,144,145, 146,147,148,149,150,164,165,166,167, 168,169,172,173,174,175,176,179,180, 181	96
SAC	1,2,3,4,7,8,9,10,12,13,14,16,17,18, 22,23,24,25,26,27,28,29,30,31,32,33, 34,35,36,37,38,39,40,41,43,45,46,48, 50,51,52,53,54,55,56,57,58,59,60,61, 62,63,64,65,66,67,68,69,70,71,72,73, 74,75,76,77,78,79,80,81,82,83,84,85, 86,87,88,89,90,91,92,93,94,96,97,102, 103,104,105,106,107,108,109,116,117 118,119,122,124,126,128,130,132,133, 134,136,137,138,139,140,141,142,143, 144,145,146,147,148,149,150,164,165, 166,167,168,169,172,173,174,175,176, 179,180,181	134
ADC	1,2,3,4,5,7,8,9,10,12,13,14,22,27,28, 29,30,31,32,33,34,35,36,37,38,39,40, 41,42,43,50,51,52,53,54,55,56,57,82, 83,84,85,86,87,88,89,90,91,92,93,94, 96,97,110,111,116,117,119,122,123,128, 129,130,131,132,133,134,136,137,138,	94

Operators	Information Elements	Total
	139,140,141,142,143,144,151,154,155, 156,160,161,164,165,166,167,172,173, 174,175,176,179,180,181	
ADR	3,4,9,14,27,28,29,30,31,32,33,34,39, 42,52,53,56,57,84,87,89,92,93,94,97, 119,122,123,128,130,131,132,133,174, 175,179,180,181	38
ASC	1,2,3,7,8,9,10,12,13,14,16,17,18,22, 23,24,25,32,33,35,36,37,39,40,41,42, 43,45,46,48,50,51,52,53,54,55,56,57, 58,59,60,61,62,63,64,65,66,67,68,69, 70,71,72,73,74,75,76,77,78,79,80,81, 82,83,84,85,86,87,88,89,90,91,92,94, 97,102,103,104,105,106,107,108,110, 111,124,125,126,127,130,131,132,133, 134,136,137,138,139,140,141,142,143, 144,145,146,147,148,149,150,152,153, 156,157,158,162,163,166,167,168,169, 172,179,180,181	123
ASR	5,9,14,16,17,18,22,23,24,32,33,34,39, 42,45,46,48,50,51,54,55,61,62,63,64, 65,66,67,68,69,70,71,72,73,74,75,76, 77,78,79,80,81,82,83,85,86,87,88,89, 90,91,124,125,126,127,130,131,132,133, 136,137,138,139,140,141,142,143,145, 146,147,148,149,150,,168,169,179	76
ICO	1,2,9,12,13,14,34,35,36,37,38,39,96, 110,116,119,132,133,134,151,154,155, 156	23
TDC	1,2,9,14,39,96,97,102,104,105,106, 107,108,110,111,116,117,118,119,122, 128,132,133,134,136,137,138,139,140, 141,142,143,151,154,155,156,168	37
TAWO	1,2,3,7,8,10,39,40,41,42,43,45,50,51, 52,54,56,58,61,62,63,68,69,70,71,72, 73,74,82,84,87,89,92,93,94,97,102, 103,104,105,106,107,108,109,123,136, 137,138,139,140,141,142,143,144,145, 146,147,148,149,150,175	61
ASWO	1,2,3,7,8,10,39,40,41,42,43,46,53, 55,57,59,64,65,66,75,76,77,78,79,80,	53

Operators	Information Elements	Total
	81,82,83,85,86,87,88,89,90,91,136, 137,138,139,140,141,142,143,144,145, 146,147,148,149,150,159,160,161	
IWO	3,4,5,7,9,14,17,18,36,39,40,43,60, 102,103,104,105,106,107,108,109,111, 122,123,125,126,127,128,129,130,131 132,133,134,136,137,138,139,140,141, 142,143,144,145,146,147,148,149,150, 159,160,161	52
CC	5,26,36,39	4
MC	2,26,28,39,110,111,116,151,152,153, 154,155,156,157,158,159,160,161,162 163	20
Plotter	1,2,3,4,7,8,9,10,14,16,17,18,22,23, 24,25,26,27,28,29,30,31,32,33,34,39, 42,45,46,48,50,51,52,53,54,55,56,57, 61,62,63,64,65,66,67,68,69,70,71,72, 73,74,75,67,77,78,79,80,81,82,83,84, 85,86,87,88,89,90,91,92,93,94,96,97, 102,103,104,105,106,107,108,109,110, 111,119,122,123,124,125,126,127,128, 130,131,132,133,136,137,138,139,140, 141,142,143,145,146,147,148,149,150, 169,174,175,179	114
G-3 WO	1,2,3,4,8,9,10,13,14,39,40,41,43,50, 51,52,53,54,55,56,57,58,59,60,61,62, 63,64,65,66,82,83,84,85,86,87,88,89, 90,91,92,93,102,103,104,105,106,107, 108,109,123,125,127,129,131,132,133, 134,136,137,138,139,140,141,142,143, 145,146,147,148,149,150,164,165,166, 167,168,169,172,173,174,175,176,179, 180,181	86
ACO	2,22,23,24,25,27,29,30,31,32,33,34, 39,40,43,116	16
Air Boss	1,2,8,10,39,40,41,42,43,45,46,50,51, 52,53,54,55,56,67,61,63,64,66,68,69, 70,71,72,73,74,75,76,77,78,79,80,81, 82,83,84,85,86,88,89,90,91,92,94,97, 123,145,146,147,148,149,150	57

Operators	Information Elements	Total
TAOC		
SAD	1,2,3,4,5,7,8,10,11,22,27,28,30,35, 36,37,38,40,41,42,43,52,53,57,61,62, 63,64,65,66,68,69,70,71,72,73,74,75, 76,77,78,79,80,81,85,86,88,89,92,93, 94,96,97,98,99,100,101,102,103,104, 105,106,107,108,109,110,111,112,113, 114,116,117,118,119,120,121,122,123, 128,132,133,134,136,137,138,139,140, 141,142,143,144,151,154,155,156,159, 165,167,175	99
CC	5,22,27,28,29,30,31,36,38,96	10
Plotter A	7,8,50,51,61,62,63,64,65,66,68,69, 70,71,72,73,74,75,76,77,78,79,80,81, 82,83,84,85,86,87,88,94,100,101	34
Plotter B	1,2,4,5,27,28,29,31,36,38,40,47,96, 101	14
Plotter C	22,30,52,53,54,55,56,57,89,90,91,92, 93,97,98,101,122,123,128,174,175	21
SID	1,2,3,4,5,7,8,22,27,28,35,36,37,38, 40,41,89,92,93,96,97,98,101,102,103, 104,105,106,107,108,109,110,111,112, 113,114,115,116,117,118,132,133,134, 136,137,138,139,140,141,142,143,151, 154,155,156,159,165,167	58
TDC	1,2,3,4,5,7,8,27,28,35,37,38,40,41, 92,93,96,102,103,104,105,106,107,108, 109,110,111,112,113,114,115,116,117, 118,119,122,128,132,133,134,136,137, 138,139,140,141,142,143,151,154,155, 156	53
SO	1,2,3,4,5,7,8,27,28,37,40,41,47,92, 93,96,102,103,104,105,106,107,108, 109,110,111,112,113,114,115,116,117, 118,132,133,134,136,137,138,139,140, 141,142,143,151,154,155,156,159	49
ECCM Op	1,2,3,4,28,38,132,136,137,138,139, 140,141,142,143	15

Operators	Information Elements	Total
STD	1,2,3,4,5,7,8,10,22,27,28,35,36,37, 38,40,41,42,43,61,62,63,64,65,66,68, 69,70,71,72,73,74,75,76,77,78,79,80, 81,85,86,88,89,92,93,94,96,97,98,99, 100,101,102,103,104,105,106,107,108, 109,110,111,112,113,114,122,128,132, 133,134,136,137,138,139,140,141,142, 143,144,151,154,155,156	83
TATC	1,2,3,4,5,7,8,10,22,27,28,37,38,40, 41,42,47,85,86,88,92,93,94,96,97,98, 100,101,110,111,112,113,114,122,128, 132,133,134,136,137,138,139,140,141, 142,143,151,154,155,156	50
SWD	1,2,3,4,5,7,8,10,11,22,27,28,30,35, 36,37,38,40,41,43,52,53,57,89,92,93, 94,96,97,98,99,100,101,102,103,104, 105,106,107,108,109,110,111,112,113, 114,119,120,121,122,123,128,132,133, 134,136,137,138,139,140,141,142,143, 144,151,154,155,156	68
AIC	1,2,3,4,5,7,8,10,22,27,28,37,40,41, 43,47,92,93,94,96,97,98,99,100,101, 102,103,104,105,106,107,108,109,110, 111,112,113,114,119,120,122,123,128, 132,133,134,136,137,138,139,140,141, 142,143,151,154,155,156,165,167,175	61
MC	1,2,3,4,5,7,8,10,11,27,28,30,35,37, 40,41,43,93,96,97,98,101,102,103,104, 105,106,107,108,109,110,111,112,113, 114,119,120,121,128,132,133,134,136, 137,138,139,140,141,142,143,151,154, 155,156,165,167,175	57
AWC	1,2,3,4,5,7,8,10,27,28,40,41,93,96, 101,102,103,104,105,106,107,108,109, 110,111,112,113,114,120,123,128,132, 133,134,136,137,138,139,140,141,142, 143,151,154,155,156	46
EW/C Crew		
EW/C Dir	1,2,3,4,5,7,8,10,11,22,27,28,35,37, 40,41,42,43,92,93,94,96,97,98,99,100,	65

Operators	Information Elements	Total
	102,103,104,105,106,107,108,109,110, 111,112,113,114,117,118,119,120,121, 122,123,128,132,133,134,136,137,138, 139,140,141,142,143,151,154,155,156, 159,167,175	
SO	1,2,3,4,5,7,8,27,28,37,40,41,47,92, 93,96,102,103,104,105,106,107,108, 109,110,111,112,113,114,117,118,132, 133,134,136,137,138,139,140,141,142, 143,151,154,155,156,159	47
TATC	1,2,3,4,5,7,8,10,22,27,28,40,41,42, 47,92,93,94,96,97,98,102,103,104,105, 106,107,108,109,110,111,112,113,114, 122,123,128,132,133,134,136,137,138, 139,140,141,142,143,151,154,155,156	52
AIC	1,2,3,4,5,7,8,10,22,27,28,37,40,41, 43,47,92,93,94,96,97,98,102,103,104, 105,106,107,108,109,110,111,112,113, 114,119,120,122,123,128,132,134,136, 137,138,139,140,141,142,143,151,154, 155,156	54
MC	1,2,3,4,5,7,8,10,11,27,28,35,37,40, 41,43,47,92,93,94,96,97,98,102,103, 104,105,105,106,107,108,109,110,111, 112,113,114,119,120,121,128,132, 133,134,136,137,138,139,140,141,142, 143,151,154,155,156,165,167	58
AWC	1,2,3,4,5,8,10,27,28,40,41,93,96,102, 103,104,105,106,107,108,109,110,111, 112,113,114,122,123,128,132,133,134, 136,137,138,139,140,141,142,143,151, 154,155,156,175	45
ECCM Op	1,2,3,4,28,132,136,137,138,139,140, 141,142,143	14
SAWWC Crew		
SAAWC	1,2,3,4,5,7,8,9,10,11,14,22,27,28, 30,35,36,37,38,40,41,43,52,53,56,57, 68,69,70,71,72,73,74,75,76,77,78,79, 80,81,82,83,84,87,89,90,91,92,93,94,	91

Operators	Information Elements	Total
	96,97,98,99,100,122,123,128,129,131, 132,133,134,136,137,138,139,140,141, 142,143,144,151,154,155,156,159,160, 161,164,165,166,167,171,173,174,175, 176,179,180,181	
SAAWC Ops	1,2,3,4,5,7,8,9,10,11,14,22,27,28,29, 30,32,35,36,37,38,40,41,43,50,51,52, 53,54,55,56,57,68,69,70,71,72,73,74, 75,76,77,78,79,80,81,82,83,84,87,89, 90,91,92,93,94,97,98,99,100,119,122, 123,128,129,130,131,132,133,136,137, 138,139,140,141,142,143,144,151,154, 155,156,159,160,161,164,165,166,167, 168,172,173,174,175,176,179,180,181	98
CC	5,27,28,29,30,31	6
S-2 Officer	3,4,5,27,28,30,122,123,132,133,134, 136,137,138,139,140,141,142,143,151, 154,155,156,159,160,161,173	27
SAW Rep *	1,2,3,4,5,7,9,10,11,14,27,28,29,30, 31,32,35,37,40,41,97,98,102,103,104, 105,106,107,108,109,129,130,131,132, 133,134,136,137,138,139,140,141,142, 143,144,156,160,161,164,165,166,167, 172,173,174	55
HAWK Crew Positions		
BN CP		
S-1 Officer	9,14,176	3
S-2 Officer	3,5,9,14,29,31,47,93,96,110,111,119, 128,129,132,133,134,136,137,138,139, 140,141,142,143,144,151,154,155,156, 160,161,164,165,177	35
S-3 Officer	1,2,3,4,5,9,10,11,14,27,29,30,31,32, 35,37,40,41,43,47,93,96,97,98,102, 103,104,105,106,107,108,109,110,111, 116,119,121,128,129,130,131,132,133, 134,136,137,138,139,140,141,142,143, 144,151,154,155,156,160,161,164,165, 166,167,174,175,176,177,179,180,181	70

Operators	Information Elements	Total
TD	1,2,3,4,5,9,10,11,14,27,29,30,31,32, 35,37,40,41,43,47,93,96,97,98,102, 103,104,105,106,107,108,109,110,111, 112,113,116,119,121,128,129,130,132, 133,134,136,137,138,139,140,141,142, 143,144,151,154,155,156,160,161,164, 165,166,167,174,175,176,179,180,181	70
Ops Assistant	1,2,3,4,5,9,10,11,14,27,29,30,31,32, 35,37,40,41,43,47,93,96,97,98,102, 103,104,105,106,107,108,109,110,111, 112,113,114,115,116,119,121,128,129, 130,131,132,133,134,136,137,138,139, 140,141,142,143,144,151,154,155,156, 160,161,164,165,166,167,174,175,176, 177,179,180,181	74
Journal Recorder	1,2,3,4,5,9,10,11,14,27,29,30,31,32, 35,37,40,41,43,47,93,96,97,98,102, 103,104,105,106,107,108,109,110,111, 112,113,114,115,116,119,121,128,129, 130,132,133,134,136,137,138,139,140, 141,142,143,144,151,154,155,156,160, 161,164,165,174,175,176	67
NBC NCO	3,9,14	3
Comm Operators	3,5,9,14,29,31,32,129,130,131,134, 144,160,161,164,165,166,167,174,175, 177,179,180,181	24
Plotter	1,2,3,4,9,10,11,14,27,29,30,31,35, 37,40,41,43,47,93,96,97,98,102,103, 104,105,106,107,108,109,110,111,119, 121,129,132,133,134,136,137,138,139, 140,141,142,143,144,151,154,155,156, 174,175,176	54
LAAD Rep	1,2,3,4,5,9,10,14,27,30,32,35,37,40, 41,93,96,97,98,102,103,104,105,106, 107,108,109,110,111,128,130,131,132, 133,134,136,137,138,139,140,141,142, 143,144,151,154,155,156,161,164,165, 166,167,179,180,181	56
S-4 Officer	9,14,174,175,176	5

Operators	Information Elements	Total
HAWK BFU		
TCO	1,2,4,9,10,11,14,27,30,35,37,40,41, 43,47,93,96,97,98,102,103,104,105, 106,107,108,109,110,111,112,113,114, 115,116,118,119,121,128,132,133,136, 137,138,139,140,141,142,143,151,154, 155,156,164,165,178	55
TCA	1,2,3,4,9,10,11,14,27,30,35,37,40, 41,43,47,93,96,97,98,102,103,104, 105,106,107,108,109,110,111,112,113, 114,115,116,118,119,128,132,133,134, 136,137,138,139,140,141,142,143,151, 154,155,156,160,161,164,165,174,175, 178	60
ASO	1,2,4,9,10,11,14,27,30,35,37,40,41, 43,47,93,96,97,98,102,103,104,105, 106,107,108,109,110,111,112,112,114, 115,116,118,119,128,132,133,136,137, 138,139,140,141,142,143,151,154,155, 156,164,165,175	54
FCO	1,2,4,9,10,11,14,27,30,35,37,40,41, 43,47,93,96,97,98,102,103,104,105, 106,107,108,109,110,111,112,113,114, 115,116,118,119,128,132,133,136,137, 138,139,140,141,142,143,151,154,155, 156,178	52
HAWK AFU		
TO	1,2,4,9,10,11,14,27,30,35,37,40,41, 43,47,93,96,97,98,102,103,104,105, 106,107,108,109,110,111,112,113,114, 115,116,118,119,121,128,132,133,134, 136,137,138,139,140,141,142,143,151, 154,155,156,160,161,164,165,174,175, 178	60
RO	1,2,4,9,10,11,14,27,30,35,37,40,41, 43,47,93,96,97,98,102,103,104,105, 106,107,108,109,110,111,112,113,114, 115,116,118,119,121,128,132,133,136, 137,138,139,140,141,142,143,151,154, 155,156,178	53

Operators	Information Elements	Total
PCP Operator	177	1
COC,BFU or AFU		
OIC	3,5,9,14,29,31,32,102,103,104,105, 106,107,108,109,129,130,131,134,144, 160,161,164,165,166,167,174,176,177, 178,179,180,181	33
Comm Operator	3,5,9,14,29,31,32,129,130,131,134, 144,160,161,164,165,166,167,174,176, 177,179,180,181	24
Recorder/Plotter	1,2,4,5,9,10,11,14,27,29,30,31,35, 37,40,41,43,47,93,96,97,98,102,103, 104,105,106,107,108,109,110,111,112, 113,114,116,118,119,121,128,129,132, 133,134,136,137,138,139,140,141,142, 143,151,154,155,156,160,161,174,175, 176,178	62
GD NCOIC	3,9,14,144	4
NBC NCOIC	3,9,14	3
LAAD Rep	1,2,4,5,9,10,14,27,30,32,35,37,40, 41,93,96,97,98,102,103,104,105,106, 107,108,109,110,111,128,130,131,132, 133,134,136,137,138,139,140,141,142, 143,144,151,154,155,156,161,164,165, 166,167,179,180,181	55
LAAD Crew		
BIC		
OIC	1,2,3,5,9,10,14,32,35,37,40,41,93, 97,98,102,103,104,105,105,106,107, 108,109,130,131,132,133,132,136,137, 138,139,140,141,142,143,144,156,161, 166,167,179,180,181	45
Admin/Log	14,32,181	3
Asset Plotter	32,179,180,181	4
Track Plotter	102,103,104,105,106,107,108,109, 130,131	10

Operators	Information Elements	Total
LAAD Platoons		
Platoon Cmdr	1,2,3,9,10,14,32,35,37,40,41,97,98, 102,103,104,105,106,107,108,109,130, 131,132,133,134,136,137,138,139,140, 141,142,143,144,156,161,166,167,179, 180,181	42
Section Leader	1,2,3,9,10,14,32,35,37,97,98,102, 103,104,105,106,107,108,109,130,131, 132,133,134,136,137,138,139,140,141, 142,143,144,156,161,166,167,179,180, 181	40
Section Comm Op	1,2,3,9,10,14,32,35,37,97,98,102, 103,104,105,106,107,108,109,130,131, 132,133,134,136,137,138,139,140,141, 142,143,144,156,161,166,167,179,180, 181	40
Team Leader	1,2,3,9,10,14,32,35,37,97,98,102, 103,104,105,106,107,108,109,130,131, 132,133,134,136,137,138,139,140,141, 142,143,144,156,161,166,167,179,180, 181	40
DASC Crew		
SAD	1,2,3,5,7,8,9,10,14,16,17,18,22,23, 24,25,32,35,36,37,40,41,43,45,46, 47,48,50,51,52,53,54,55,56,57,58, 59,60,61,62,63,64,65,66,67,68,69, 70,71,72,73,74,75,76,77,78,79,80, 81,82,83,84,85,86,87,88,89,90,91, 92,94,97,98,102,103,104,105,106,107, 108,109,110,111,112,113,114,124,125, 126,127,130,131,132,133,134,136,137, 138,139,140,141,142,143,144,145,146, 147,148,149,150,152,153,156,157,158, 161,162,163,166,167,168,169,172,179, 180,181	126
TAD	1,2,3,5,8,10,16,17,22,23,24,25,36,40, 41,43,45,48,50,54,58,60,61,62,63,64, 66,67,68,69,70,71,72,73,74,75,76,79, 80,81,82,83,84,85,86,87,89,90,91,92, 94,97,98,102,103,104,105,106,107,108,	90

Operators	Information Elements	Total
	109,110,111,112,113,114,124,125,132, 133,134,136,137,138,139,140,141,142, 143,145,146,147,148,149,152,153,156, 157,158,162,168	
HD	1,2,3,5,8,10,16,17,22,23,24,25,36, 40,41,43,46,48,50,51,54,55,59,61,64, 65,66,67,68,69,70,71,72,73,74,75,76, 77,78,79,80,81,82,83,84,85,86,87,88, 89,90,91,92,97,98,102,103,104,105, 106,107,108,109,112,113,114,126,127, 132,133,134,136,137,138,139,140,141, 142,143,145,146,147,148,149,152,153, 156,157,158,162,168	91
CC	1,2,3,5,7,8,9,10,14,16,17,18,22,23, 24,25,32,35,36,37,40,41,43,45,46, 47,48,50,51,52,53,54,55,56,57,58, 59,60,61,62,63,64,65,66,67,68,69, 70,71,72,73,74,75,76,77,78,79,80, 81,82,83,84,85,86,87,88,89,90,91, 92,94,97,98,102,103,104,105,106,107, 108,109,110,111,112,113,114,124,125, 126,127,130,131,132,133,134,136,137, 138,139,140,141,142,143,144,145,146, 147,148,149,150,152,153,156,157,158, 161,162,163,166,167,168,169,172,179, 180,181	126
TAR/HR	1,2,3,7,8,10,22,23,25,35,37,40,41, 45,46,48,50,51,54,55,58,59,61,62,63, 65,66,67,68,69,70,71,72,73,74,75,76, 77,78,79,80,82,83,85,86,88,90,102, 103,104,105,106,107,108,109,136,137, 138,139,140,141,142,143,144,145,158, 163	67
DAS	1,2,3,7,8,10,22,23,35,36,37,40,41, 43,45,46,48,50,51,52,53,54,55,56,57, 58,59,60,61,62,63,46,56,66,67,68,69, 70,71,72,73,74,75,76,77,78,79,80,81, 82,83,84,85,86,87,88,89,90,91,92,97, 98,102,103,104,105,106,107,108,109, 132,136,137,138,139,140,141,142,143, 145,146,147,148,149,150,168,169,172, 179,180,181	91

Operators	Information Elements	Total
TAC	1,2,3,5,9,10,14,16,17,18,23,24,32, 35,37,40,41,43,94,97,102,103,104, 105,106,107,108,109,124,125,126,130, 131,133,144,152,153,156,157,158,161, 162,163,166,167,168,172,179,180,181	50
ACN	1,3,7,8,10,16,17,18,22,23,24,35,37, 40,41,43,45,46,47,48,58,59,61,62,63, 64,65,66,67,68,69,70,71,72,73,74,75, 76,77,78,79,80,81,82,85,86,88,89,90, 94,97,98,102,103,104,105,106,107,108, 109,110,111,112,113,114,132,133,134, 136,137,138,139,140,141,142,143,145, 146,147,148,149,150,168,169	84
Plotter	1.3.7.8.16.17.18.23.24.25.35.37.40. 41,43,45,47,48,59,60,61,62,63,64,65, 66,67,68,69,70,71,72,73,74,75,76,77, 78,79,80,81,82,83,84,85,86,87,88,89, 90,91,92,97,89,124,125,126,127,132, 133,134,136,137,138,139,140,141,142, 143,145,146,147,148,149,150,168,169	77
TAC(A) *	1,3,5,10,22,23,24,25,40,41,43,45,50, 51,62,66,67,68,74,79,81,82,83,85,86, 88,89,90,94,97,98,102,103,104,105, 106,107,108,109,112,113,114,124,125, 136,137,138,139,140,141,142,143,145, 146,147,148,149,156,157,158,168	61
HC(A) *	1,2,3,5,10,22,23,24,25,40,41,43,50, 51,54,,55,65,66,67,75,76,79,81,82, 83,85,86,88,97,98,102,103,104,105, 106,107,108,109,126,127,136,137,138, 139,140,141,142,143,144,145,146,147, 148,149,156,157,158,168	58
LAAD Rep *	1,2,3,9,10,14,32,35,37,40,41,97,102, 103,104,105,105,106,107,108,109,130, 131,132,133,134,136,137,138,139,140, 141,142,143,156,161,166,167,179,180, 181	41
INTEL O *	3,35,37,132,134,136,137,138,139,140, 141,142,143,145,146,147,148,149,150, 168	20

*Included in CNA diagrams,but not included in lists.

Operators	Information Elements	Total
FSCC Crew		
TACP/FAC	1,2,3,7,8,10,22,23,35,37,40,41,43, 45,46,48,49,50,51,54,55,61,62,63, 64,65,66,67,68,69,70,71,72,73,74, 75,76,77,78,79,80,82,83,85,86,88, 90,102,103,104,105,106,107,108,109, 132,133,134,136,137,138,139,140,141, 142,143,144,145,146,147,158,163	72
Bn FSC	1,2,3,5,7,8,9,10,15,17,22,23,35,37, 40,41,43,44,48,49,50,51,54,55,61,62, 63,64,65,66,67,68,69,70,71,72,73,74, 75,76,77,78,79,80,81,82,83,85,86,88, 89,90,91,97,98,102,103,104,105,106, 107,108,109,132,133,134,136,137,138, 139,140,141,142,143,144,145,146,147, 148,149,150,158,163,168,169,172	86
Bn AO	1,2,3,5,7,8,9,10,17,22,23,35,37,40, 41,43,44,48,49,50,51,54,55,61,62,63, 64,65,66,67,68,69,70,71,72,73,74,75, 76,77,78,79,80,81,82,83,85,86,88,89, 90,91,97,98,102,103,104,109,132,133, 134,136,137,138,139,140,141,142,143, 144,145,146,147,148,149,150,158,163, 168,169,172	91
Regt FSC	1,2,3,5,7,8,9,10,14,15,17,18,22,23, 32,35,37,40,41,43,44,45,46,48,49,50, 51,54,55,61,62,63,64,65,66,67,68,69, 70,71,72,73,74,75,76,77,78,79,80,81, 82,83,85,86,88,89,90,91,97,98,102, 103,104,105,106,107,108,109,130,131, 132,133,134,136,137,138,139,140,141, 142,143,144,145,146,147,148,149,150, 156,158,161,163,166,167,168,169,172, 179,180,181	100
Regt AO	1,2,3,5,7,8,9,10,17,18,23,35,37,40, 41,43,44,45,46,48,49,50,51,54,55,61, 62,63,64,65,66,67,68,69,70,71,72,73, 74,75,76,77,78,79,80,81,82,83,85,86, 88,89,90,91,97,98,102,103,104,109, 132,133,134,136,137,138,139,140,141, 142,143,144,145,146,147,148,149,150, 163,168,169,172	92

Operators	Information Elements	Total
Div ASST FSC	1,2,3,5,7,8,9,10,14,15,16,17,18,22, 23,32,35,37,40,41,43,44,45,46,48,49, 50,51,54,55,60,61,62,63,64,65,66,67, 68,69,70,71,72,73,74,75,76,77,78,79, 80,81,82,83,85,86,88,89,90,91,97,98, 102,103,104,105,106,107,108,109,130, 131,132,133,134,136,137,138,139,140, 141,142,143,144,145,146,147,148,149, 150,156,158,161,163,166,167,168,169, 172,179,180,181	102
Div AO	1,2,3,5,7,8,9,10,16,17,18,23,35,37, 40,41,43,44,45,46,48,49,50,51,54,55, 60,61,62,63,64,65,66,67,68,69,70,71, 72,73,74,75,76,77,78,79,80,81,82,83, 85,86,88,89,90,91,97,98,102,103,104, 109,132,133,134,136,137,138,139,140, 141,142,143,144,145,146,147,148,149, 150,163,168,169,172	94
Bn S-3 *	1,2,3,7,8,23,44,49,50,51,54,102,103, 104,105,106,107,108,132,133,134,136, 137,138,139,140,141,142,143,144,145, 146,147,148,149,163,168,169	38
Regt S-3 *	1,2,3,7,8,23,44,49,50,51,54,102,103, 104,105,106,107,108,132,133,134,136, 137,138,139,140,141,142,143,144,145, 146,147,148,149,163,168,169	38
Div G-3 *	1,2,3,7,8,9,23,44,49,50,51,54,60,102, 103,104,105,106,107,108,132,133,134, 136,137,138,139,140,141,142,143,144, 145,146,147,148,149,163,168,169	40

*Included in CNA diagrams, but not included on lists.

TABLE A-3

MEDIUMS/PATHS VERSUS OPERATORS

Mediums/Paths	Operators	Total (131)
Non-radio		
FF	All except these use FF: ACE:G-3 Plans Officer,G-3 FW/RW Fragger,Sqdn Flight Officer TACC:ADC,ADR,ASR,TDC,Plotter,ACO Air Boss TAOC:SAD,SID,TDC,SO,ECCM Op,STD, TATC,SWD,AIC,MC,AWC EW/C:EW/C Dir,SO,TATC,AIC,MC,AWC, ECCM Op SAAWC:S-2 Officer HAWK:BN CP:LAAD Rep BFU:FCO COC:Recorder/Plotter,LAAD Rep LAAD: Platoon Cmdr DASC:TAC(A),HC(A) FSCC:TACP/FAC	94
INT	ACE:None TACC:TAC,SAC,ADC,ADR,ASC,ICO,TDC, TAWO,ASWO,CC,MC,Plotter,ACO TAOC:SAD,CC,Plotter A,SID,TDC,SO, STD,TATC,SWD,AIC,MC,AWC EW/C:EW/C Dir,SO,TATC,AIC,MC,AWC SAAWC:SAAWC,SAAWC Ops,S-2 Officer, SAW Rep HAWK:BN CP:S-3 Officer,Ops Assist, Journal/Recorder BFU:TCO,TCA,FCO AFU:TO COC:OIC LAAD:None DASC:SAD,TAD,HD,CC,TAR/HR,DAS,TAC, ACN,Plotter,LAAD Rep,Intel O FSCC:None	54
LOC HOT	ACE:None TACC:None TAOC:SID,ECCM Op EW/C:EW/C Dir,ECCM Op SAAWC:None HAWK:None	4

Mediums/Paths	Operators	Total
	LAAD: None DASC: None FSCC: None	
CON DIS	ACE: None TACC: None TAOC: SAD, SID, TDC, SO, STD, TATC, SWD, AIC, MC, AWC EW/C: None HAWK: None LAAD: None DASC: None FSCC: None	10
PM	All except these use PM: ACE: G-3WEO, G-3 C3CMO, MAG S-3 WEO, Sqdn WTI TACC: TAWO, ASWO, CC, MC, G-3 WO, Air Boss TAOC: Plotter C, TDC, SO, ECCM Op, AIC, MC, AWC EW/C: SO, TATC, AIC, MC, AWC, ECCM Op SAAWC: SAAWC, SAAWC Ops, CC, S-2 Officer, SAW Rep HAWK: BN CP: S-1, S-2, S-3, TD, Ops Assist, Journal/Recorder, NBC NCO, Plotter, LAAD Rep, S-4 BFU: TCO, TCA, ASO, FCO AFU: TO, RO, PCP Operator COC: OIC, Comm Op, Plotter/Recorder, GD NCOIC, NBC NCO, LAAD Rep LAAD: BIC: OIC, Admin/Log, Asset Plotter, Track Plotter Platoon: Platoon Cmdr, Team Leader DASC: TAC(A), HC(A) FSCC: TACP/FAC, Bn AO, Regt AO, Div AO, Bn S-3, Regt S-3, Div G-3	65
SB	ACE: G-1 Officer, G-2 Officer, G-3 Ops Officer, G-3 Plans Officer, G-3 ACO, MAG S-1 Officer, MAG S-3 Officer, MAG S-3 Fragger, MAG AMO, Sqdn S-1 Officer, Sqdn S-3 Officer, Sqdn ODO, Sqdn Ordnance Officer, Aircrew TACC: ADC, ASR, IWO, ACO TAOC: SAD, Plotter A, Plotter B, Plotter C, SID, STD, TATC, SWD, AIC, MC, AWC EW/C: EW/C Dir, SO, TATC, AIC, MC, AWC	41

Mediums/Paths	Operators	Total
	SAAWC:SAAWC,SAAWC Ops,S-2 Officer, SAW Rep HAWK:BN CP Plotter LAAD:None DASC:Plotter FSCC:None	
TEL	ACE:G-2 Officer,G-3 FW/RW Fragger, G-3 ACO,G-3 C3CMO,G-4 Officer, MAG S-3 Officer,MAG S-3 Fraager, Sqdn S-3 Officer,Sqdn ODO,Sqdn Ordnance Officer TACC:TAWO,ASWO,IWO,CC,MC,G-3 WO, Air Boss TAOC:CC EW/C:None SAAWC:CC HAWK:Bn CP Comm Op,LAAD Rep,COC Comm Op LAAD:OIC DASC:LAAD Rep FSCC:None	24
LAN	ACE:G-3 Ops Officer,G-3 FW/RW Fragger,MAG S-3 Officer,Sqdn Ordnance Officer TACC:SAC,TAWO,ASWO,CC,MC,G-3 WO, Air Boss TAOC:None EW/C:None SAAWC:SAAWC Ops,CC HAWK:None LAAD:None DASC:SAD FSCC:Div AO,Regt FSC	16
Radio Nets		
ACE	None	0
TACmd	ADC,ASC,ASR,ASWO(TACC);SAAWC, SAAWC Ops,SAW Rep(SAAWC);Comm Op,LAAD Rep(HAWK BN CP);OIC (LAAD BIC);TAC(DASC).	11
ACE INTEL	G-2 Officer,MAG S-2 Officer,Sqdn S-2 Officer(ACE);IWO(TACC);S-2	7

Mediums/Paths	Operators	Total
	Officer(SAAWC);Comm Op(HAWK BN CP);Intel O(DASC).	
ACE FSC	None	0
ACE COMM COORD	None	0
LAAM BN Cmd	Comm Op(HAWK BN CP);Comm Op (HAWK COC).	2
LCN	SAW Rep(SAAWC);LAAD Rep(HAWK BN CP);OIC,Track Plotter(LAAD BIC);Platoon Cmdr(LAAD).	5
CA	ADC(TACC);SAD(TAOC)SAAWC Ops (SAAWC).	3
AOC-1	ADC(TACC);SAAWC Ops(SAAWC).	2
AOC-2	SAD(TAOC);EW/C Dir(EW/C).	2
CID-1	None	0
CID-2	SAD,SO(TAOC;EW/C Dir,SO(EW/C).	4
CID-3 *	SO(TAOC).	1*
VPN	TDC(TACC).	1
H/O	STD,TATC(TAOC);ACN(DASC).	3
LWCN	Platoon Cmdr,Section Comm Op (LAAD).	2
LTCN	Section Comm Op,Team Leader(LAAD).	2
ICN	ICO(TACC).	1
TSN	ICO,TDC(TACC);TDC(TAOC).	3
DCN	ICO(TACC).	1
DAS	ASC(TACC);DAS(DASC).	2
TAR/HR	TAR/HR(DASC);TACP/FAC(FSCC).	2

*Included in CNA diagrams, but not included on lists.

Mediums/Paths	Operators	Total
ACN	ACN(DASC).	1
TACP LOCAL	TACP/FAC(FSCC).	1
TATC	Aircrew(ACE);TATC(TAOC);TATC (EW/C);TAD,HD(DASC).	5
FAD	Aircrew(ACE);AIC(TAOC).	2
AAC *	MC(TAOC);TD,Ops Assist,Plotter, LAAD Rep(HAWK BN CP);TCO(HAWK BFU); TO(HAWK AFU);Recorder/Plotter, LAAD Rep(HAWK COC);OIC(LAAD BIC).	10
AAI *	MC,SO(TAOC);TD,Plotter(HAWK BN CP); TCA(HAWK BFU);RO(HAWK AFU);Recorder/ Plotter(HAWK COC);Track Plotter(LAAD BIC).	8
TAD	Aircrew(ACE);TAD,TAC(A)(DASC).	3
HD	Aircrew(ACE);HD,HC(A)(DASC).	3
TANKER	None	0
TA	G-3 Officer,G-3 Ops Officer,MAG S-3 Officer,Sqdn S-3 Officer(ACE); ADC,ASC(TACC);SAAWC(SAAWC).	7
SQD CMN	ODO,Aircrew(ACE).	2
GRP CMN	None	0
TOWER	None	0
TOWER-2	None	0
GND	None	0
APP	None	0
DEP	None	0
GCA	None	0
GUARD	None	0

Mediums/Paths	Operators	Total
CFR	None	0
SAR	None	0
ATC CMN	None	0
AB SECURITY	None	0
LZ CNTL	None	0
LZ CNTL TM LOCAL	None	0
EVAC COORD (AIR)	None	0
EVAC COORD (GND)	None	0
LF Cmd	G-3 Officer(ACE).	1
LF TAC	G-3 Officer(ACE).	1
LF INTEL	G-2 Officer(ACE).	1
LF CSS	None	0
LF COMM COORD	None	0
BN TAC	None	0
RGT TAC	Regt FSC,Bn FSC(FSCC).	2
DIV TAC	Div FSC,Regt FSC(FSCC).	2
RGT CMD	None	0
DIV CMD	None	0
DIV INTEL	None	0
DIV RECON	None	0
DIV AIR OBS	None	0
BTRY COF	None	0
BN COF	None	0
BN MORTAR COF	None	0

Mediums/Paths	Operators	Total
BN FD	None	0
RGT FD	None	0
ARTY BN CMD	None	0
ARTY RGT CMD	None	0
ARTY RGT TAC	None	0
SURVEY/MET	None	0
ARTY AIR SPOT	None	0
RGT FSC	Regt FSC,Bn FSC(FSCC).	2
DIV FSC	Div FSC,Regt FSC(FSCC).	2
SFCP LOCAL	None	0
NGF AIR SPOT	None	0
NGF GND SPOT	None	0
DIV NGF SUPPORT	None	0
DIV RADAR BCN	None	0
AAWC/R	None	0
Data Links		
TADIL-A	TDC(TACC);TDC(TAOC).	2
TADIL-B	TDC(TACC);TDC(TAOC).	2
TADIL-C	Aircrew(ACE);AIC(TAOC).	2
ATDL-1	SO,MC(TAOC);TCO(HAWK BFU); TO(HAWK AFU).	4

TABLE A-4

MEDIUMS/PATHS VERSUS INFORMATION

Mediums/Paths	Information Elements	Total
Non-radio		
FF	All information except the following is exchanged FF:21,33,34,42, 47,101,110,119,120,151,159,162, 170,180	167
INT	All information except the following is exchanged INT:5,6,15,17,19, 20,21,26,33,34,44,49,87,93,115, 170,171,177	163
LOC HOT	1,2,3,4,27,28,36,38,132,133,134, 136,137,138,139,140,141,142,143, 151,154,155,156	23
CON DIS	47,101,102,103,104,105,106,107, 108,109,110,111,112,113,114,115, 119,121,122,128,138,139	21
PM	1,2,3,5,8,9,10,12,13,14,16,17,18, 19,20,21,22,23,24,25,27,28,29,30, 31,32,33,34,35,36,40,41,44,45,46, 48,49,50,51,52,53,54,55,56,57,58, 59,60,61,62,63,64,65,66,67,68,69, 70,71,72,73,74,75,76,77,78,79,80, 81,82,83,85,86,87,88,89,90,91,92, 93,94,95,96,97,98,102,103,104,105, 106,107,108,109,110,111,112,113,114, 116,122,123,124,125,126,127,128,129, 130,131,132,133,134,135,136,137,138, 139,140,141,142,143,144,145,146,147, 148,149,150,152,153,156,158,160,161, 162,163,164,165,166,167,168,169,170, 171,172,173,174,175,176,177,178,179, 180,181	154
SB	1,2,3,5,6,8,9,10,19,20,22,23,24,25, 27,28,29,30,31,32,33,34,36,37,38,40, 41,42,47,50,68,69,70,71,72,73,74,75, 76,77,78,79,80,81,94,95,96,101,120,	68

Mediums/Paths	Information Elements	Total
	122,123,135,136,137,138,139,140,141, 142,143,144,145,146,147,148,149,150, 171	
TEL	1,2,3,5,6,8,9,10,12,13,14,16,17,18, 22,26,27,28,29,30,31,32,33,35,36,37, 38,39,40,41,42,43,45,56,58,50,51,52, 53,54,55,56,57,60,61,63,64,66,67,68, 69,70,71,72,73,74,75,76,77,78,79,80, 81,82,83,84,85,86,87,88,89,90,91,92, 93,94,95,96,97,98,102,103,104,105, 106,107,108,109,123,130,131,132,133, 134,136,137,138,139,140,141,142,143, 144,145,145,147,148,149,150,151,154, 155,156,158,159,160,161,162,163,164, 165,166,167,168,169,172,175,176,177, 178,179,180,181	133
LAN	1,2,3,5,8,10,12,13,14,16,17,18,22,23, 24,25,26,32,33,35,36,37,39,40,41,42, 43,45,46,48,50,51,52,53,54,55,56,57, 60,61,63,64,66,67,68,69,70,71,72,73, 74,75,76,77,78,79,80,81,82,83,85,86, 87,88,89,90,91,92,93,94,96,97,98,102, 103,104,105,106,107,108,109,123,130, 131,132,133,134,136,137,138,139,140, 141,142,143,144,145,146,147,148,149, 150,151,154,155,156,158,159,160,161, 162,163,164,165,166,167,168,169,172, 175,179,180,181	123
Radio Nets		
ACE	None	0
TACmd	1,2,3,4,5,9,10,14,16,17,18,23,24,25, 27,29,31,32,35,37,40,41,53,56,57,94, 97,98,102,103,104,105,106,107,108, 109,124,125,126,127,129,130,131,132, 133,134,136,137,138,139,140,141,142, 143,144,152,153,156,157,158,160,161, 162,163,164,165,166,167,168,172,173, 174,175,176,179,180,181	77
ACE INTEL	36,102,103,104,105,106,107,108,109, 111,123,125,127,128,131,132,133,134, 136,137,138,139,140,141,142,143,144, 145,146,147,148,149,150,159,160,161	36

Mediums/Paths	Information Elements	Total
ACE FSC	None	0
ACE COMM COORD	None	0
LAAM BN Cmd	3,9,29,31,32,129,130,131,134,144, 160,161,164,165,166,167,176,179, 180,181	20
LCN	1,2,3,5,9,10,14,32,35,37,40,102, 103,104,105,106,107,108,109,130, 131,132,133,134,136,137,138,139, 140,141,142,143,144,156,161,166, 167,179,180,181	40
CA	10,35,36,117,151,154,155,156	8
AOC-1	1,8,40,41,50,51,52,53,54,55,56, 57,82,83,84,85,87,89,90,91,92,93, 94,97,98,119,122,128,136,137,138, 139,140,141,142,143,175	37
AOC-2	1,3,4,5,8,10,11,27,28,35,40,41,43, 92,93,94,96,97,98,99,100,112,113, 114,118,119,120,121,122,123,128, 132,133,134,136,137,138,139,140, 141,142,143,151,155,156,165,167, 175	48
CID-1	None	0
CID-2	2,22,37,42,47,102,103,104,105,106, 107,108,109,110,111,112,113,114, 117,159	20
VPN	109	1
H/O	8,22,40,43,47,61,62,63,64,65,66, 68,69,70,71,72,73,74,75,76,77,78, 79,80,81,85,86,88,94,97,98,102, 103,104,105,106,107,108,109,110, 111,112,113,114,144	45
LWCN	1,2,3,9,10,35,97,98,102,103,104, 105,106,107,108,109,132,133,134, 136,137,138,139,140,141,142,143, 144,156,161,166,167,179,180,181	35

Mediums/Paths	Information Elements	Total
LTCN	1,2,3,9,10,35,97,98,102,103,104, 105,106,107,108,109,132,133,134, 136,137,138,139,140,141,142,143, 144,156,161,166,167,179,180,181	35
ICN	2,34,36,116	4
TSN	35,37,96,102,103,104,105,106,107, 108,109,110,111,116,118,119,151, 154,155,156	20
DCN	116	1
DAS	1,2,3,8,10,22,23,25,35,36,37,40, 41,43,45,46,48,50,51,52,53,54,55, 56,57,58,59,60,61,62,63,64,66,66, 67,68,69,70,71,72,73,74,75,76,77, 78,79,80,81,82,83,85,86,87,88,89, 90,91,92,102,103,104,105,106,107, 108,109,132,136,137,138,139,140, 141,142,143,145,146,147,148,149, 150,168,169,172,179,180,181	88
TAR/HR	1,2,3,8,10,22,23,25,35,40,41,43, 45,46,48,49,50,51,54,55,58,59,61, 62,65,66,67,68,69,70,71,72,73,74, 75,76,77,78,79,80,82,83,85,86,88, 90,102,103,104,105,106,107,108, 109,136,137,138,139,140,141,142, 143,144,145,158,163	66
ACN	1,3,8,10,16,17,18,22,23,35,37,40, 41,43,45,46,47,48,58,59,61,62,65, 66,67,68,69,70,71,72,73,74,75,76, 77,78,79,80,82,85,88,89,90,97,98, 102,103,104,105,106,107,108,109, 110,111,132,133,134,136,137,138, 139,140,141,142,143,144,145,146, 147,148,149,150,168,169	75
TACP LOCAL	10,25,32,49,61,62,63,64,65,66,67, 68,69,70,71,72,73,74,75,76,77,78, 79,80,82,83,85,86,88,90,91,132, 134,137,144,147,158,163	38
TATC	1,2,3,5,10,22,27,40,41,43,45,46, 47,50,51,54,55,62,65,66,67,68,69,	76

Mediums/Paths	Information Elements	Total
	74,75,76,79,81,85,86,88,90,92,93, 94,97,98,101,102,103,104,105,106, 107,108,109,110,111,112,113,114, 122,124,125,126,127,128,136,137, 138,139,140,141,142,143,151,152, 153,154,155,156,157,158,168	
FAD	1,2,3,10,27,40,41,42,43,47,92,93, 94,97,98,101,102,103,104,105,106, 107,108,109,112,113,114,119,120, 122,123,126,136,137,138,139,140, 141,142,143,151,154,155,156	44
AAC *	1,2,4,10,11,27,30,35,37,40,41,96, 97,98,119,121,128,132,133,136,137, 138,139,140,141,142,143,175	28
AAI *	43,47,93,102,103,104,105,106,107, 108,109,110,111,112,113,114,115, 116,118,151,154,155,156	23
TAD	1,2,3,5,10,22,23,24,25,40,41,43, 45,50,54,62,66,67,68,74,79,81,82, 83,85,86,88,89,90,94,97,9,102,103, 104,105,106,107,108,109,124,125, 136,137,138,139,140,141,142,143, 152,153,156,157,158,168	56
HD	1,2,3,5,10,22,23,24,25,40,41,43, 46,50,51,54,55,65,66,67,75,76,79, 81,82,83,85,86,88,91,97,98,102, 103,104,105,106,107,108,109,126, 127,136,137,138,139,140,141,142, 143,152,153,156,157,158,168	56
TANKER	None	0
TA	1,3,4,40,41	5
SQD CMN	8,132,133,134	4
GRP CMN	None	0
TOWER	None	0
TOWER-2	None	0

Mediums/Paths	Information Elements	Total
GND	None	0
APP	None	0
DEP	None	0
GCA	None	0
GUARD	None	0
CFR	None	0
SAR	None	0
ATC CMN	None	0
AB SECURITY	None	0
LZ CNTL	None	0
LZ CNTL TM LOCAL	None	0
EVAC COORD (AIR)	None	0
EVAC COORD (GND)	None	0
LF Cmd	21,44	2
LF TAC	1,21,40,41,145,146,147,148,149, 150	10
LF INTEL	102,103,104,105,106,107,108,109, 111,132,133,134,136,137,138,139, 140,141,142,143,144,145,146,147, 148,149,150	27
LF CSS	None	0
LF COMM COORD	None	0
BN TAC	None	0
RGT TAC	1,2,3,40,41,102,103,104,105,106, 107,108,109,132,133,136,137,138, 139,140,141,142,143,144	24
DIV TAC	1,2,3,14,40,41,102,103,104,105,	25

Mediums/Paths	Information Elements	Total
	106,107,108,109,132,133,136,137, 138,139,140,141,142,143,144	
RGT CMD	None	0
DIV CMD	None	0
RGT INTEL	132,133,134,136,137,138,139,140, 141,142,143,144,158,163	14
DIV INTEL	132,133,134,136,137,138,139,140, 141,142,143,144,156,158,161,163	16
DIV RECON	None	0
DIV AIR OBS	None	0
BTRY COF	None	0
BN COF	None	0
BN MORTAR COF	None	0
BN FD	None	0
RGT FD	None	0
ARTY BN CMD	None	0
ARTY RGT CMD	None	0
ARTY RGT TAC	None	0
SURVEY/MET	None	0
ARTY AIR SPOT	None	0
RGT FSC	5,15,23,24,25,35,37,43,44,48,49, 50,51,54,55,61,62,63,64,65,66,67, 68,69,70,71,72,73,74,75,76,77,78, 79,80,81,82,83,85,86,88,89,90,91, 97,98,145,146,147,148,149,168,169, 172	54
DIV FSC	5,15,23,24,25,32,35,37,43,44,48, 49,50,51,54,55,60,61,62,63,64,65, 66,67,68,69,70,71,72,73,74,75,76,	63

Mediums/Paths	Information Elements	Total
	77,78,79,80,81,82,83,85,86,88,89, 90,91,97,98,130,131,145,146,147, 148,149,166,167,168,169,172,179, 180,181	
SFCP LOCAL	None	0
NGF AIR SPOT	None	0
NGF GND SPOT	None	0
DIV NGF SUPPORT	None	0
DIV RADAR BCN	None	0
AAWC/R	None	0
Data Links		
TADIL-A	102,103,104,105,106,107,108,109, 110,111,122,128,138,139,151,154, 155,156	18
TADIL-B	102,103,104,105,106,107,108,109, 110,111,122,128,138,139,151,154, 155,156	18
TADIL-C	1,41,93,102,103,104,105,106,107, 108,109,110,111,120,122,123,128, 138,139	19
ATDL-1	93,96,102,103,104,105,106,107,108, 109,110,111,116,119,121,128,138, 139	18

TABLE A-5

INFORMATION VERSUS OPERATORS

Information Elements	Operators ACE	TACC	TAOC	EW/C	SAAWC	HAWK	LAAD	DASC	FSCC	TOT
1.Alert/Weapon	6	12	12	6	3	14	5	11	10	79
2.EMCON Status	12	12	12	7	3	12	5	10	10	83
3.NBC Status	6	10	11	7	4	15	5	13	10	81
4.Air Raid War	0	7	12	7	4	0	0	0	0	30
5.Weather Rep	9	6	12	6	5	12	0	5	6	61
6.Aviation Wea	2	0	0	0	0	0	0	0	0	2
7.ATO/FRAG Dis	11	7	15	7	3	0	0	6	9	58
8.ATO/FRAG Upd	6	9	10	6	2	0	0	8	10	51
9.ACE COO Upd	4	12	0	0	3	25	8	4	6	62
10.ROE Update	4	11	7	5	3	14	5	9	7	65
11.HAWK PTL Up	0	0	3	2	3	12	0	0	0	20
12.COMM Plan	6	5	0	0	0	0	0	0	0	11
13.Deception	5	6	0	0	0	0	0	0	0	11
14.GCE COO Up	7	12	0	0	3	25	6	4	2	59
15.Friendly Un	0	0	0	0	0	0	0	0	9	9
16.Target List	0	4	0	0	0	0	0	6	2	12
17.OAS/AS Targ	1	6	0	0	0	0	0	7	6	20
18.ASRT Immed	1	6	0	0	0	0	0	5	4	16
19.ACE Person	14	0	0	0	0	0	0	0	0	14
20.ACE Tasking	10	0	0	0	0	0	0	0	0	10
21.MAGTF Task	6	0	0	0	0	0	0	0	0	6

Information Elements	Operators ACE	TACC	TAOC	EW/C	SAAWC	HAWK	LAAD	DASC	FSCC	TOT
22. Airfield	6	8	8	3	2	0	0	7	6	40
23. DASC Status	6	5	0	0	0	0	0	10	16	37
24. ASRT Status	6	5	0	0	0	0	0	7	6	24
25. GCE/TC Stat	6	5	0	0	0	0	0	6	7	24
26. TACC COMM	0	4	0	0	0	0	0	0	0	4
27. TAOC Status	6	5	11	6	5	14	0	0	0	50
28. TAOC COMM	0	5	11	7	5	0	0	0	0	28
29. TAOC Equip	6	5	2	0	3	12	0	0	0	28
30. HAWK Status	6	5	5	0	5	14	0	0	0	35
31. HAWK Equip	6	5	2	0	1	11	0	0	0	25
32. LAAD Status	6	8	0	0	2	10	7	4	2	39
33. MATCS Status	6	7	0	0	0	0	0	0	0	13
34. ECA Status	6	6	0	0	0	0	0	0	0	12
35. MACCS Agenc	6	6	6	2	3	14	5	9	6	57
36. COMM Coord	2	6	6	0	2	0	0	5	0	21
37. MACCS Cas	0	6	9	4	3	14	5	9	6	56
38. TAOC Reconf	0	4	10	0	2	0	0	0	0	16
39. TACC Crew	0	19	0	0	0	0	0	0	0	19
40. ACP Change (DASC/FSCC)	6	11	11	6	3	14	2	12	7	72
41. ACP Change (TACC)	6	9	11	6	3	14	2	12	7	70
42. ALR/R Chang	0	8	3	2	0	0	0	0	0	13
43. RPV Control	0	10	5	3	2	12	0	9	7	48

Information Elements	Operators ACE	TACC	TAOC	EW/C	SAAWC	HAWK	LAAD	DASC	FSCC	TOT
44. Proposed HRC	3	0	0	0	0	0	0	0	9	12
45. FW RIO-DASC	0	6	0	0	0	0	0	8	5	19
46. RW RIO-DASC	0	6	0	0	0	0	0	6	5	17
47. A/C RIO-TAOC	0	0	3	4	0	12	0	4	0	23
48. A/C FTR	0	4	0	0	0	0	0	8	7	19
49. Preplan TAR	3	0	0	0	0	0	0	0	13	16
50. On-call FW	0	9	1	0	1	0	0	8	10	29
51. On-call RW	0	9	1	0	1	0	0	6	10	27
52. On-call FW	0	9	3	0	2	0	0	3	0	17
53. On-call RW	0	9	3	0	2	0	0	3	0	17
54. Immed FW	0	9	1	0	1	0	0	8	10	29
55. Immed RW	0	9	1	0	1	0	0	6	10	27
56, Immed FW	0	9	3	0	2	0	0	3	0	17
57. Immed RW	0	9	3	0	2	0	0	3	0	17
58. Immed TAR	0	5	0	0	0	0	0	6	1	12
59. Immed ASR	0	5	0	0	0	0	0	7	1	13
60. GCE SEAD	0	5	0	0	0	0	0	5	4	14
61. Route Chang (FW Deck)	0	8	3	0	0	0	0	8	7	26
62. Route Chang (FW Enroute)	0	7	3	0	0	0	0	8	7	25
63. Route Chang (FW Forward)	0	8	3	0	0	0	0	7	7	25
64. Route Chang (RW Deck)	0	8	3	0	0	0	0	8	7	26

Information Elements	Operators ACE	TACC	TAOC	EW/C	SAAWC	HAWK	LAAD	DASC	FSCC	TOT
65. Route Change (RW Enroute)	0	7	3	0	0	0	0	8	7	25
66. Route Change (RW FARP)	0	8	3	0	0	0	0	10	7	28
67. GCE App Div	0	4	0	0	0	0	0	10	7	21
68. FW OAS Stat	0	6	3	0	2	0	0	9	7	27
69. TAR Status (FW)	0	6	3	0	2	0	0	8	7	26
70. TAR Status (FAC(A))	0	6	3	0	2	0	0	7	7	25
71. TAR Status (TACP)	0	6	3	0	2	0	0	7	7	25
72. TAR Status (AO)	0	6	3	0	2	0	0	7	7	25
73. TAR Status (DASC)	0	6	3	0	2	0	0	7	7	25
74. TAR Status (TAC(A))	0	6	3	0	2	0	0	8	7	26
75. ASR Status (HC(A)/RW)	0	6	3	0	2	0	0	8	7	26
76. ASR Status (Unit)	0	6	3	0	2	0	0	8	7	26
77. ASR Status (AO)	0	6	3	0	2	0	0	6	7	24
78. ASR Status (DASC)	0	6	3	0	2	0	0	6	7	24
79. ASR Status (TAC(A))	0	6	3	0	2	0	0	10	7	28
80. ASRT Mission	0	6	3	0	2	0	0	7	7	25
81. Troop Lift	0	6	3	0	2	0	0	9	6	26

Information Elements	Operators ACE	TACC	TAOC	EW/C	SAAWC	HAWK	LAAD	DASC	FSCC	TOT
82. FW OAS Stat	1	9	1	0	2	0	0	10	7	30
83. RW OAS Stat	1	9	1	0	2	0	0	9	7	29
84. AAW A/C Stat	1	9	1	0	2	0	0	6	0	19
85. FW Stat-DASC	1	9	4	0	0	0	0	10	7	31
86. RW Stat-DASC	1	9	4	0	0	0	0	10	7	31
87. FSA Status	1	10	1	0	2	0	0	6	0	20
88. FSA Sta-DASC	1	9	4	0	0	0	0	10	7	31
89. Strip Status	1	11	5	0	2	0	0	8	6	33
90. OAS Strip	0	9	1	0	2	0	0	9	7	28
91. RW Strip	0	9	1	0	2	0	0	7	6	25
92. AAW Strip	0	9	9	4	2	0	0	6	0	30
93. CAP Status	1	7	11	6	2	15	1	0	0	43
94. Tanker Stat	0	7	6	3	2	0	0	7	0	25
95. A/C Locat	9	0	0	0	0	0	0	0	0	9
96. Sensor Man	0	5	12	6	1	14	0	0	0	38
97. FEZ Status	0	8	8	4	3	14	5	6	6	54
98. MEZ Status	0	8	8	4	3	14	5	6	6	54
99. CAP Manning	0	0	4	1	2	0	0	0	0	7
100. Tanker Plan	0	0	5	1	2	0	0	0	0	8
101. SA Update	0	0	10	0	0	0	0	0	0	10
102. HAWK Detect	4	10	9	6	1	15	10	10	0	65
103. LAAD Detect	4	10	9	6	1	15	10	10	0	65
104. TAOC Detect	4	10	9	6	1	15	10	10	0	65

Information Elements	Operators ACE	TACC	TAOC	EW/C	SAAWC	HAWK	LAAD	DASC	FSCC	TOT
105. AAW A/C Det	4	10	9	6	1	15	10	10	0	65
106. FW OAS Det	4	10	9	6	1	15	10	10	0	65
107. RW OAS Det	4	10	9	6	1	15	10	10	0	65
108. GCE Detect	4	10	9	6	1	15	10	10	1	66
109. Other Det	4	10	9	6	1	15	10	10	0	65
110. Track-Frnd	0	6	10	6	0	15	0	3	0	40
111. Track-Host	3	6	10	6	0	15	0	3	0	43
112. ID/Classify (TAOC)	0	0	10	6	0	10	0	6	0	22
113. ID/Classify (HAWK)	0	0	10	6	0	10	0	6	0	22
114. ID/Classify (Aircraft)	0	0	10	6	0	10	0	6	0	22
115. IFF Info	0	0	3	0	0	10	0	0	0	13
116. Data Link	0	6	4	0	0	11	0	0	0	21
117. Manual Cr	0	4	4	2	0	0	0	0	0	10
118. Manual Cr	0	3	4	2	0	7	0	0	0	16
119. AAW Target	0	6	5	3	1	13	0	0	0	28
120. A/C Fire O	0	0	5	3	0	0	0	0	0	8
121. HAWK Fire	0	0	3	2	0	8	0	0	0	13
122. AAW A/C St	0	7	8	4	3	0	0	0	0	22
123. AAW A/C En	5	7	5	3	3	0	0	0	0	23
124. FW OAS A/C	0	6	0	0	0	0	0	6	0	12
125. FW OAS Sum	5	5	0	0	0	0	0	6	0	16
126. RW Eng. Rep	0	6	0	0	0	0	0	6	0	12

Information Elements	Operators ACE	TACC	TAOC	EW/C	SAAWC	HAWK	LAAD	DASC	FSCC	TOT
127.RW OAS Sum	5	5	0	0	0	0	0	6	0	16
128.HAWK Eng.	0	7	9	5	2	14	0	0	0	37
129.HAWK Sum	5	3	0	0	3	11	0	0	0	22
130.LAAD Eng.	0	9	0	0	2	9	6	4	3	33
131.LAAD Sum	5	8	0	0	3	9	6	4	0	35
132.Intel Spot	11	12	11	7	4	15	5	9	10	84
133.GCE Intel	11	12	11	7	4	15	5	9	10	84
134.INTSUM	11	10	11	7	4	15	5	8	10	81
135.Pilot Debr	8	0	0	0	0	0	0	0	0	8
136.FW OAS Info	10	12	11	7	4	15	5	12	10	86
137.RW OAS Info	10	12	11	7	4	15	5	12	10	86
138.AAW A/C In	10	12	11	7	4	15	5	12	10	86
139.HAWK Info	10	12	11	7	4	15	5	12	10	86
140.LAAD Info	10	12	11	7	4	15	5	12	10	86
141.GCE Info	10	12	11	7	4	15	5	12	10	86
142.RPV Info	10	12	11	7	4	15	5	12	10	86
143.ESM Info	10	12	11	7	4	15	5	12	10	86
144.TGF Info	10	8	2	0	3	14	5	6	11	59
145.BDA-TACP	9	8	0	0	0	0	0	10	10	37
146.BDA-AO	9	8	0	0	0	0	0	9	11	37
147.BDA-FW	9	8	0	0	0	0	0	9	9	35
148.BDA-RW	9	8	0	0	0	0	0	9	9	35
149.BDA-TAC(A)	9	8	0	0	0	0	0	9	9	35

Information Elements	Operators ACE	TACC	TAOC	EW/C	SAAWC	HAWK	LAAD	DASC	FSCC	TOT
150. BDA-Air B	9	8	0	0	0	0	0	6	0	23
151. EW/FIR-AAW	0	5	11	6	3	15	0	0	0	40
152. EW/FIR-FW	0	3	0	0	0	0	0	7	0	10
153. EW/FIR-RW	0	3	0	0	0	0	0	7	0	10
154. EW/FIR-TAOC	0	5	11	7	3	15	0	0	0	41
155. EW/FIR-HAWK	0	5	11	7	3	15	0	0	0	41
156. EW/FIR-LAAD	0	7	11	6	4	15	5	8	2	58
157. EW/FIR-DASC	0	3	0	0	0	0	0	7	0	10
158. EW/FIR-GCE	0	3	0	0	0	0	0	8	6	17
159. MIJI-TAOC	0	3	3	2	3	0	0	0	0	11
160. MIJI-HAWK	0	4	0	0	4	12	0	0	0	20
161. MIJI-LAAD	0	6	0	0	4	13	5	4	2	34
162. MIJI-DASC	0	3	0	0	0	0	0	5	0	8
163. MIJI-GCE	0	3	0	0	0	0	0	4	10	17
164. HAWK Move	0	4	0	0	3	15	0	0	0	22
165. HAWK Move	0	4	4	2	3	15	0	0	0	28
166. LAAD Move	0	6	0	0	3	9	5	4	2	29
167. LAAD Move	0	6	4	2	3	9	5	4	2	35
168. FS Coord	0	6	0	0	2	0	0	10	9	27
169. Sup Arms I	0	6	0	0	0	0	0	5	9	20
170. Ground Sup	3	0	0	0	0	0	0	0	0	3
171. AMO Status	6	0	0	0	0	0	0	0	0	6
172. Ordnance	15	5	0	0	3	0	0	4	6	33

Information Elements	Operators ACE	TACC	TAOC	EW/C	SAAWC	HAWK	LAAD	DASC	ESCC	TOT
173. TAOC Resup	7	4	4	0	4	0	0	0	0	19
174. HAWK Inv.	0	6	1	0	3	13	0	0	0	23
175. HAWK Emerg	7	7	4	2	3	10	0	0	0	33
176. HAWK Admin	7	4	0	0	3	10	0	0	0	24
177. HAWK CMS	1	0	0	0	0	8	0	0	0	9
178. HAWK Reloa	0	0	0	0	0	7	0	0	0	7
179. LAAD Inv.	0	9	0	0	3	9	6	5	2	34
180. LAAD Emerg	7	9	0	0	3	9	6	5	2	41
181. LAAD Admin	7	9	0	0	3	9	7	5	2	42

TABLE A-6

INFORMATION VERSUS MEDIUMS/PATHS

Information Elements	Mediums/Paths	Total
1.Alert/Weapon CC	FF,INT,LOC HOT,PM,SB,TEL, LAN,TACmd,AOC-1,AOC-2,LWCN, LTCN,ACN,TATC,FAD,AAC,TAD, HD,LF TAC,RGT TAC,DIV TAC, TADIL-C	22
2.EMCON Status	FF,INT,LOC HOT,PM,SB,TEL LAN,TACmd,ACE CSS,LCN,CID-2, ICN,TATC,FAD,AAC	15
3.NBC Status	FF,INT,LOC HOT,PM,SB,TEL, LAN,TACmd,LCN,AOC-2,LWCN, LTCN,TATC,FAD,TAD,HD,TA, RGT TAC,DIV TAC	19
4.Air Raid Warning	FF,INT,LOC HOT,TACmd,AOC-2, AAC,TA	7
5.Weather Report	FF,PM,SB,TEL,LAN,TACmd,LCN, AOC-2,TATC,TAD,HD,RGT FSC, DIV FSC	13
6.Aviation Weather	FF,SB,TEL	3
7.ATO/FRAG Distrib	FF,INT,PM,AOC-2,TAR/HR,LF CMD	6
8.ATO/FRAG Update	FF,INT,PM,SB,TEL,LAN,AOC-1, AOC-2,H/O,DAS,TAR/HR,ACN, SQD CMN	13
9.ACE COO Update	FF,INT,PM,SB,TEL,LAN,TACmd, LAAM BN Cmd,LCN	9
10.ROE Update	FF,INT,PM,SB,TEL,LAN,TACmd, LCN,CA,AOC-2,DAS,ACN,TACP LOCAL,TATC,FAD,AAC,TAD,HD	18
11.HAWK PTL Update	FF,INT,AOC-2,AAC	4
12.COMM Plan	FF,INT,PM,TEL,LAN	5

Information Elements	Mediums/Paths	Total
13. Deception Plan	FF, INT, PM, TEL, LAN	5
14. GCE COO Update	FF, INT, PM, SB, TEL, LAN, TACmd, LCN	8
15. Friendly Unit Loc	FF, RGT FSC, DIV FSC	3
16. Target List	FF, INT, PM, LAN, TACmd, ACN	5
17. OAS/AS Target Up.	FF, PM, TEL, LAN, TACmd, ACN, RGT FSC, DIV FSC	8
18. ASRT Immediate	FF, INT, PM, TEL, LAN, TACmd, ACN	7
19. ACE Personnel	FF, PM, SB	3
20. ACE Tasking	FF, PM, SB	3
21. MAGTF Tasking	PM, LF Cmd, LF TAC	3
22. Airfield Status	FF, INT, PM, SB, TEL, LAN, CID-2, H/O, DAS, TAR/HR, ACN, TACP LOCAL, TAD, HD, RGT FSC, DIV FSC	16
23. DASC Status	FF, INT, PM, SB, LAN, TACmd, DAS, TAR/HR, ACN, TATC, TAD, HD, RGT FSC, DIV FSC	14
24. ASRT Status	FF, INT, PM, SB, LAN, TACmd, ACN, TATC, TAD, HD, RGT FSC, DIV FSC	12
25. GCE/TC Status	FF, INT, PM, SB, LAN, TACmd, TAR/HR, TACP LOCAL, TAD, HD, RGT FSC, DIV FSC	12
26. TACC COMM Stat	FF, TEL, LAN	3
27. TAOC Status	FF, INT, LOC HOT, PM, SB, TEL, TACmd, AOC-2, TATC, FAD, AAC	11
28. TAOC COMM Stat	FF, INT, LOC HOT, PM, SB, TEL, AOC-2	7
29. TAOC Equip Rep	FF, INT, PM, SB, TEL, TACmd, LAAM BN Cmd	7
30. HAWK Status	FF, INT, PM, SB, TEL, AAC	6

Information Elements	Mediums/Paths	Total
31. HAWK Equip Rep	FF, INT, PM, SB, TEL, TACmd, LAAM BN Cmd	7
32. LAAD Status	FF, INT, PM, SB, TEL, LAN, TACmd, LAAM BN Cmd, LCN, DIV FSC	10
33. MATCS Status	PM, SB, TEL, LAN	4
34. ECA Status	PM, SB, ICN	3
35. MACCS Agency	FF, INT, PM, TEL, LAN, TACmd LCN, CA, AOC-2, TSN, DAS, TAR/HR, ACN, AAC, RGT FSC, DIV FSC	16
36. COMM Coord	FF, INT, LOC HOT, PM, SB, TEL, LAN, ACE INTEL, CA, ICN, DAS	11
37. MACCS Casualty	FF, INT, PM, TEL, LAN, TACmd, LCN, CID-2, TSN, DAS, TAR/HR, ACN, AAC, RGT FSC, DIV FSC	15
38. TAOC Reconfig	FF, INT, LOC HOT, SB, TEL	5
39. TACC Crew Con	FF, INT, TEL, LAN	4
40. ACP Change (DASC-FSCC)	FF, INT, PM, TEL, LAN, TACmd, LCN, AOC-1, AOC-2, H/O, DAS, TAR/HR, ACN, TATC, FAD, AAC, TAD, HD, TA, LF TAC, RGT TAC, DIV TAC	22
41. ACP Change (TACC)	FF, INT, PM, SB, TEL, LAN, TACmd, AOC-1, AOC-2, DAS, TAR/HR, ACN, TATC, FAD, AAC, TAD, HD, TA, LF TAC, RGT TAC, DIV TAC, TADIL-C	22
42. ALR/R Change	INT, SB, TEL, LAN, CID-2, TATC	6
43. RPV Control	FF, INT, TEL, LAN, AOC-2, H/O, DAS, TAR/HR, ACN, TATC, FAD, AAI, TAD, HD, RGT FSC, DIV FSC	16
44. Proposed HRC	FF, PM, LF Cmd, RGT FSC, DIV FSC	5
45. FW RIO-DASC	FF, INT, PM, TEL, LAN, DAS, TAR/HR, ACN, TATC, TAD	10

Information Elements	Mediums/Paths	Total
46. RW RIO-DASC	FF, INT, PM, TEL, LAN, DAS, TAR/HR, ACN, TATC	9
47. A/C RIO-TAOC	INT, CON DIS, PM, CID-2, H/O, TATC, FAD, AAI	8
48. A/C FTR	FF, INT, PM, LAN, DAS, TAR/HR, ACN, RGT FSC, DIV FSC	9
49. Preplan TAR/HR	FF, PM, TAR/HR, TACP LOCAL, LF Cmd, RGT FSC, DIV FSC	7
50. On-call FW TAR	FF, INT, PM, TEL, LAN, AOC-1, DAS, TAR/HR, TATC, TAD, HD, RGT FSC, DIV FSC	13
51. On-call RW OAS	FF, INT, PM, TEL, LAN, AOC-1, DAS, TAR/HR, TATC, HD, RGT FSC, DIV FSC	12
52. On-call FW AAW	FF, INT, PM, TEL, LAN, AOC-1, DAS	7
53. On-call RW AAW	FF, INT, PM, TEL, LAN, TACmd, AOC-1, DAS	8
54. Immed FW TAR	FF, INT, PM, TEL, LAN, AOC-1, DAS, TAR/HR, TATC, TAD, HD, RGT FSC, DIV FSC	13
55. Immed RW OAS	FF, INT, PM, TEL, LAN, AOC-1, DAS, TAR/HR, TATC, HD, RGT FSC, DIV FSC	12
56, Immed FW AAW	FF, INT, PM, TEL, LAN, TACmd, AOC-1, DAS	8
57. Immed RW AAW	FF, INT, PM, TEL, LAN, TACmd. AOC-1, DAS	8
58. Immed TAR	FF, INT, PM, DAS, TAR/HR, ACN	6
59. Immed ASR	FF, INT, PM, DAS, TAR/HR, ACN	6
60. GCE SEAD	FF, INT, PM, LAN, DAS, RGT FD, DIV FSC	7
61. Route Change (FW Deck)	FF, INT, PM, TEL, LAN, H/O, DAS, TAR/HR, ACN	9

Information Elements	Mediums/Paths	Total
62. Route Change (FW Enroute)	FF, INT, PM, LAN, H/O, DAS, TAR/HR, ACN, TACP LOCAL, TATC, TAD, RGT FSC, DIV FSC	13
63. Route Change (FW Forward)	FF, INT, PM, TEL, LAN, H/O, DAS, TAR/HR, ACN, TACP LOCAL, RGT FSC, DIV FSC	12
64. Route Change (RW Deck)	FF, INT, PM, TEL, LAN, H/O, DAS, TAR/HR, ACN, TACP LOCAL, RGT FSC, DIV FSC	12
65. Route Change (RW Enroute)	FF, INT, PM, H/O, DAS, TAR/HR, ACN, TACP LOCAL, TATC, HD, RGT FSC, DIV FSC	12
66. Route Change (RW FARP)	FF, INT, PM, TEL, LAN, H/O, DAS, TAR/HR, ACN, TACP LOCAL, TATC, TAD, HD, RGT FSC, DIV FSC	15
67. GCE App. Div.	FF, INT, PM, LAN, DAS, TAR/HR, ACN, TACP LOCAL, TATC, TAD, HD, RGT FSC, DIV FSC	13
68. FW OAS Status	FF, INT, PM, SB, TEL, LAN, H/O, DAS, TAR/HR, ACN, TACP LOCAL, TATC, TAD, RGT FSC, DIV FSC	15
69. TAR Status (FW)	FF, INT, PM, SB, TEL, LAN, H/O, DAS, TAR/HR, ACN, TACP LOCAL, TATC, RGT FSC, DIV FSC	14
70. TAR Status (FAC(A))	FF, INT, PM, SB, TEL, LAN, H/O, DAS, TAR/HR, ACN, TACP LOCAL, RGT FSC, DIV FSC	13
71. TAR Status (TACP)	FF, INT, PM, SB, TEL, LAN, H/O, DAS, TAR/HR, ACN, TACP LOCAL, RGT FSC, DIV FSC	13
72. TAR Status (AO)	FF, INT, PM, SB, TEL, LAN, H/O, DAS, TAR/HR, ACN, TACP LOCAL, RGT FSC, DIV FSC	13
73. TAR Status (DASC)	FF, INT, PM, SB, TEL, LAN, H/O, DAS, TAR/HR, ACN, TACP LOCAL, RGT FSC, DIV FSC	13

Infromation Elements	Mediums/Paths	Total
74. TAR Status (TAC(A))	FF, INT, PM, SB, TEL, LAN, H/O, DAS, TAR/HR, ACN, TACP LOCAL, TATC, TAD, RGT FSC, DIV FSC	15
75. ASR Status (HC(A)/RW)	FF, INT, PM, SB, TEL, LAN, H/O, DAS, TAR/HR, ACN, TACP LOCAL, TATC, HD, RGT FSC, DIV FSC	15
76. ASR Status (Unit)	FF, INT, PM, SB, TEL, LAN, H/O, DAS, TAR/HR, ACN, TACP LOCAL, TATC, HD, RGT FSC, DIV FSC	15
77. ASR Status (AO)	FF, INT, PM, SB, TEL, LAN, H/O, DAS, TAR/HR, ACN, TACP LOCAL, RGT FSC, DIV FSC	13
78. ASR Status (DASC)	FF, INT, PM, SB, TEL, LAN, H/O, DAS, TAR/HR, ACN, TACP LOCAL, RGT FSC, DIV FSC	13
79. ASR Status (TAC(A))	FF, INT, PM, SB, TEl, LAN, H/O, DAS, TAR/HR, ACN, TACP LOCAL, TATC, TAD, HD, RGT FSC, DIV FSC	16
80. ASRT Mission	FF, INT, PM, SB, TEL, LAN, H/O, DAS, TAR/HR, ACN, TACP LOCAL, RGT FSC, DIV FSC	13
81. Troop Lift Stat	FF, INT, PM, SB, TEL, LAN, H/O, DAS, TATC, TAD, HD, RGT FSC, DIV FSC	13
82. FW OAS Status	FF, INT, PM, TEL, LAN, AOC-1, DAS, TAR/HR, TACP LOCAL, ACN, TAD, HD, RGT FSC, DIV FSC	14
83. RW OAS Status	FF, INT, PM, TEL, LAN, AOC-1, DAS, TAR/HR, TACP LOCAL, TAD, HD, RGT FSC, DIV FSC	15
84. AAW A/C Status	FF, INT, PM, TEL, LAN, AOC-1, DAS	7
85. FW Status-DASC	FF, INT, PM, TEL, LAN, H/O, DAS, TAR/HR, TACP LOCAL, ACN, TATC, TAD, HD, RGT FSC, DIV FSC	15
86. RW Status-DASC	FF, INT, PM, TEL, LAN, H/O, DAS,	14

Information Elements	Mediums/Paths	Total
	TAR/HR,TACP LOCAL,TATC,TAD, HD,RGT FSC,DIV FSC	
87.FSA Status	FF,PM,TEL,LAN,AOC-1,DAS	6
88.FSA Status-DASC	FF,INT,PM,TEL,LAN,H/O,DAS, TAR/HR,TACP LOCAL,ACN,TATC, TAD,HD,RGT FSC,DIV FSC	15
89.Strip Status	FF,INT,PM,TEL,LAN,AOC-1,DAS, ACN,TAD,RGT FSC,DIV FSC	11
90.OAS Strip Laun.	FF,INT,PM,TEL,LAN,AOC-1,DAS, TAR/HR,TACP LOCAL,ACN,TATC, TAD,RGT FSC,DIV FSC	14
91.RW Strip Laun.	FF,INT,PM,TEL,LAN,AOC-1, DAS,TATC,HD,RGT FSC,DIV FSC	11
92.AAW Strip Laun.	FF,INT,PM,TEL,LAN,AOC-1, AOC-2,DAS,TATC,FAD	10
93.CAP Status	FF,CON DIS,PM,TEL,LAN,AOC-1, AOC-2,TATC,FAD,AAI,TADIL-C, ATDL	12
94.Tanker Status	FF,INT,PM,SB,TEL,LAN,TACmd, AOC-1,AOC-2,H/O,TATC,FAD,TAD	13
95.A/C Location	FF,PM,SB,TEL	4
96.Sensor Manage	FF,INT,PM,SB,TEL,LAN,AOC-2, TSN,AAC,ATDL	10
97.FEZ Status	FF,INT,PM,TEL,LAN,TACmd, LCN,AOC-1,AOC-2,H/O,ACN, TATC,FAD,AAC,TAD,HD	16
98.MEZ Status	FF,INT,PM,TEL,LAN,TACmd, LCN,AOC-1,AOC-2,H/O,ACN, TATC,FAD,AAC,TAD,HD	16
99.CAP Manning	FF,INT,AOC-2	3
100.Tanker Plan	FF,INT,AOC-2	3
101.SA Update	INT,CON DIS,SB,TATC,FAD	5

Information Elements	Mediums/Paths	Total
102.HAWK Detect	FF,INT,CON DIS,PM,TEL,TACmd, ACE INTEL,LCN,CID-2,CID-3, H/O,LWCN,LTCN,TSN,DAS,TAR/HR, ACN,TATC,AAI,TAD,HD,LF INTEL, RGT TAC,DIV TAC,TADIL-A, TADIL-B,TADIL-C	27
103.LAAD Detect	FF,INT,CON DIS,PM,TEL,TACmd, ACE INTEL,LCN,CID-2,CID-3, H/O,LWCN,LTCN,TSN,DAS,TAR/HR, ACN,TATC,AAI,TAD,HD,LF INTEL, RGT TAC,DIV TAC,TADIL-A, TADIL-B,TADIL-C	27
104.TAOC Detect	FF,INT,CON DIS,PM,TEL,TACmd, ACE INTEL,LCN,CID-2,CID-3, H/O,LWCN,LTCN,TSN,DAS,TAR/HR, ACN,TATC,AAI,TAD,HD,LF INTEL, RGT TAC,DIV TAC,TADIL-A, TADIL-B,TADIL-C	27
105.AAW A/C Detect	FF,INT,CON DIS,PM,TEL,TACmd, ACE INTEL,LCN,CID-2,CID-3, H/O,LWCN,LTCN,TSN,DAS,TAR/HR, ACN,TATC,AAI,TAD,HD,LF INTEL, RGT TAC,DIV TAC,TADIL-A, TADIL-B,TADIL-C	27
106.FW OAS Detect	FF,INT,CON DIS,PM,TEL,TACmd, ACE INTEL,LCN,CID-2,CID-3, H/O,LWCN,LTCN,TSN,DAS,TAR/HR, ACN,TATC,AAI,TAD,HD,LF INTEL, RGT TAC,DIV TAC,TADIL-A, TADIL-B,TADIL-C	27
107.RW OAS Detect	FF,INT,CON DIS,PM,TEL,TACmd, ACE INTEL,LCN,CID-2,CID-3, H/O,LWCN,LTCN,TSN,DAS,TAR/HR, ACN,TATC,AAI,TAD,HD,LF INTEL, RGT TAC,DIV TAC,TADIL-A, TADIL-B,TADIL-C	27
108.GCE Detect	FF,INT,CON DIS,PM,TEL,TACmd, ACE INTEL,LCN,CID-2,CID-3, H/O,LWCN,LTCN,TSN,DAS,TAR/HR, ACN,TATC,AAI,TAD,HD,LF INTEL,	27

Information Elements	Mediums/Paths	Total
	RGT TAC, DIV TAC, TADIL-A, TADIL-B, TADIL-C	
109. Other Detect	FF, INT, CON DIS, PM, TEL, TACmd, ACE INTEL, LCN, CID-2, CID-3, VPN, H/O, LWCN, LTCN, TSN, DAS, TAR/HR, ACN, TATC, AAI, TAD, HD, LF INTEL, RGT TAC, DIV TAC, TADIL-A, TADIL-B, TADIL-C	28
110. Track-Friend	INT, CON DIS, PM, CID-2, H/O, TSN, ACN, TATC, AAI, TADIL-A, TADIL-B, TADIL-C, ATDL	13
111. Track-Hostile	FF, INT, CON DIS, PM, TEL, ACE INTEL, CID-2, H/O, TSN, ACN, TATC, AAI, LF INTEL, TADIL-A, TADIL-B, TADIL-C, ATDL	17
112. ID/Classify (TAOC)	FF, INT, CON DIS, PM, AOC-2, CID-2, H/O, TATC, FAD, AAI	10
113. ID/Classify (HAWK)	FF, INT, CON DIS, PM, AOC-2, CID-2, H/O, TATC, FAD, AAI	10
114. ID/Classify (Aircraft)	FF, INT, CON DIS, PM, AOC-2, CID-2, H/O, TATC, FAD, AAI	10
115. IFF Info	FF, CON DIS, AAI	3
116. Data Link	FF, INT, PM, ICN, TSN, DCN, AAI, ATDL	8
117. Manual Cross P.	FF, INT, CA, CID-2	4
118. Manual Cross E.	FF, INT, AOC-2, TSN, AAI	5
119. AAW Target Up.	INT, CON DIS, AOC-1, AOC-2, TSN, FAD, AAC, ATDL	8
120. A/C Fire Order	INT, SB, AOC-2, FAD, TADIL-C	5
121. HAWK Fire Ord.	FF, INT, CON DIS, AOC-2, AAC, ATDL	6
122. AAW A/C Status	FF, INT, CON DIS, PM, SB, AOC-1,	12

Information Elements	Mediums/Paths	Total
	AOC-2, TATC, FAD, TADIL-A, TADIL-B, TADIL-C	
123. AAW A/C Eng.	FF, INT, PM, SB, TEL, LAN, ACE INTEL, AOC-2, FAD, TADIL-C	10
124. FW OAS A/C Rep	FF, INT, PM, TACmd, TATC, TAD	6
125. FW OAS Summary	FF, INT, PM, TEL, TACmd, ACE INTEL, TATC, TAD	8
126. RW Eng. Rep	FF, INT, PM, TACmd, TATC, HD	6
127. RW OAS Summary	FF, INT, PM, TEL, TACmd, ACE INTEL, TATC, HD	8
128. HAWK Eng. Rep	FF, INT, CON DIS, PM, SB, AOC-1, AOC-2, TATC, FAD, AAC, TADIL-A, TADIL-B, TADIL-C, ATDL	14
129. HAWK Summary	FF, INT, PM, TEL, TACmd, ACE INTEL, LAAM BN Cmd	7
130. LAAD Eng. Rep	FF, INT, TEL, LAN, TACmd, LAAM BN Cmd, LCN, DIV FSC	8
131. LAAD Summary	FF, INT, PM, TEL, LAN, TACmd, ACE INTEL, LCN	8
132. Intel Spot	FF, INT, LOC HOT, PM, TEL, LAN, TACmd, ACE INTEL, LCN, AOC-2, LWCN, LTCN, DAS, ACN, TACP LOCAL, AAC, SQD CMN, LF INTEL, RGT TAC, DIV TAC, RGT INTEL, DIV INTEL	22
133. GCE Intel	FF, INT, LOC HOT, PM, TEL, LAN, TACmd, ACE INTEL, LCN, AOC-2, LWCN, LTCN, ACN, TACP LOCAL, AAC, SQD CMN, LF INTEL, RGT TAC, DIV TAC, RGT INTEL, DIV INTEL	21
134. INTSUM	FF, INT, LOC HOT, PM, TEL, LAN, TACmd, ACE INTEL, LAAM BN Cmd, LCN, AOC-2, LWCN, LTCN, ACN, TACP LOCAL, SQD CMN, LF INTEL, RGT INTEL, DIV INTEL	19

Information Elements	Mediums/Paths	Total
135.Pilot Debrief	FF,PM,SB	3
136.FW OAS Info	FF,INT,LOC HOT,PM,SB,TEL,LAN, TACmd,ACE INTEL,LCN,AOC-1, AOC-2,LWCN,LTCN,DAS,TAR/HR, ACN,TATC,FAD,AAC,TAD,HD,LF INTEL,RGT TAC,DIV TAC,RGT INTEL,DIV INTEL	27
137.RW OAS Info	FF,INT,LOC HOT,PM,SB,TEL,LAN, TACmd,ACE INTEL,LCN,AOC-1, AOC-2,LWCN,LTCN,DAS,TAR/HR, ACN,TATC,FAD,AAC,TAD,HD,LF INTEL,RGT TAC,DIV TAC,RGT INTEL,DIV INTEL	27
138.AAW A/C Info	FF,INT,LOC HOT,CON DIS,PM, SB,TEL,LAN,TACmd,ACE INTEL, LCN,AOC-1,AOC-2,LWCN,LTCN, DAS,TAR/HR,ACN,TATC,FAD,AAC, TAD,HD,LF INTEL,RGT TAC,DIV TAC,RGT INTEL,DIV INTEL, TADIL-A,TADIL-B,TADIL-C,ATDL	32
139.HAWK Info	FF,INT,LOC HOT,CON DIS,PM, SB,TEL,LAN,TACmd,ACE INTEL, LCN,AOC-1,AOC-2,LWCN,LTCN, DAS,TAR/HR,ACN,TATC,FAD,AAC, TAD,HD,LF INTEL,RGT TAC,DIV TAC,RGT INTEL,DIV INTEL, TADIL-A,TADIL-B,TADIL-C,ATDL	32
140.LAAD Info	FF,INT,LOC HOT,PM,SB,TEL,LAN, TACmd,ACE INTEL,LCN,AOC-1, AOC-2,LWCN,LTCN,DAS,TAR/HR, ACN,TATC,FAD,AAC,TAD,HD,LF INTEL,RGT TAC,DIV TAC,RGT INTEL,DIV INTEL	27
141.GCE Info	FF,INT,LOC HOT,PM,SB,TEL,LAN, TACmd,ACE INTEL,LCN,AOC-1, AOC-2,LWCN,LTCN,DAS,TAR/HR, ACN,TATC,FAD,AAC,TAD,HD,LF INTEL,RGT TAC,DIV TAC,RGT INTEL,DIV INTEL	27

Information Elements	Mediums/Paths	Total
142.RPV Info	FF,INT,LOC HOT,PM,SB,TEL,LAN, TACmd,ACE INTEL,LCN,AOC-1, AOC-2,LWCN,LTCN,DAS,TAR/HR, ACN,TATC,FAD,AAC,TAD,HD,LF INTEL,RGT TAC,DIV TAC,RGT INTEL,DIV INTEL	27
143.ESM Info	FF,INT,LOC HOT,PM,SB,TEL,LAN, TACmd,ACE INTEL,LCN,AOC-1, AOC-2,LWCN,LTCN,DAS,TAR/HR, ACN,TATC,FAD,AAC,TAD,HD,LF INTEL,RGT TAC,DIV TAC,RGT INTEL,DIV INTEL	27
144.TGF Info	FF,INT,PM,SB,TEL,LAN,TACmd, ACE INTEL,LAAM BN Cmd,LCN, H/O,LWCN,LTCN,TAR/HR,ACN, TACP LOCAL,LF INTEL,RGT TAC, DIV TAC,RGT INTEL,DIV INTEL	21
145.BDA-TACP	FF,INT,PM,SB,TEL,LAN,ACE INTEL,DAS,TAR/HR,ACN,TATC,TAD, HD,LF TAC,LF INTEL,RGT FSC, DIV FSC	17
146.BDA-AO	FF,INT,PM,SB,TEL,LAN,ACE INTEL,DAS,ACN,TATC,TAD, HD,LF TAC,LF INTEL,RGT FSC, DIV FSC	16
147.BDA-FW	FF,INT,PM,SB,TEL,LAN,ACE INTEL,DAS,ACN,TACP LOCAL, TATC,TAD,HD,LF TAC,LF INTEL, RGT FSC,DIV FSC	17
148.BDA-RW	FF,INT,PM,SB,TEL,LAN,ACE INTEL,DAS,ACN,TATC,TAD, HD,LF TAC,LF INTEL,RGT FSC, DIV FSC	16
149.BDA-TAC(A)	FF,INT,PM,SB,TEL,LAN,ACE INTEL,DAS,ACN,TATC,TAD, HD,LF TAC,LF INTEL,RGT FSC, DIV FSC	16
150.BDA-Air Boss	FF,PM,SB,TEL,LAN,ACE INTEL,	12

Information Elements	Mediums/Paths	Total
	DAS, ACN, LF TAC, LF INTEL, RGT FSC, DIV FSC	
151. EW/FIR-AAW	INT, LOC HOT, TEL, LAN, CA, AOC-2, TSN, TATC, FAD, AAI, TADIL-A, TADIL-B	12
152. EW/FIR-FW OAS	FF, INT, PM, TACmd, TATC, TAD, HD	7
153. EW/FIR-RW OAS	FF, INT, PM, TACmd, TATC, TAD, HD	7
154. EW/FIR-TAOC	INT, LOC HOT, TEL, LAN, CA, AOC-2, TSN, TATC, FAD, AAI, TADIL-A, TADIL-B	12
155. EW/FIR-HAWK	INT, LOC HOT, TEL, LAN, CA, AOC-2, TSN, TATC, FAD, AAI, TADIL-A, TADIL-B	12
156. EW/FIR-LAAD	INT, LOC HOT, TEL, LAN, TACmd, CA, AOC-2, TSN, TATC, FAD, AAI, TADIL-A, TADIL-B	13
157. EW/FIR-DASC	FF, INT, PM, TACmd, TATC, TAD, HD	7
158. EW/FIR-GCE	FF, INT, PM, LAN, TACmd, TAR/HR, TACP LOCAL, TATC, TAD, HD, RGT INTEL, DIV INTEL	12
159. MIJI-TAOC	INT, PM, TEL, LAN, ACE INTEL, CID-2	6
160. MIJI-HAWK	FF, INT, PM, TEL, LAN, TACmd, ACE INTEL, LAAM BN Cmd	8
161. MIJI-LAAD	FF, INT, PM, TEL, LAN, TACmd, ACE INTEL, LAAM BN Cmd, LCN, LWCN, LTCN, DIV INTEL	12
162. MIJI-DASC	INT, TEL, LAN, TACmd, ACE INTEL	5
163. MIJI-GCE	FF, INT, PM, LAN, TACmd, TAR/HR, TACP LOCAL, RGT INTEL, DIV INTEL	9
164. HAWK Move	FF, INT, PM, TEL, TACmd, LAAM BN Cmd	6

Information Elements	Mediums/Paths	Total
165. HAWK MoveOrd.	FF, INT, PM, TEL, TACmd, LAAM BN Cmd, AOC-2	7
166. LAAD Move	FF, INT, PM, TEL, LAN, TACmd, LAAM BN Cmd, LCN, LWCN, LTCN, DIV FSC	11
167. LAAD MoveOrd.	FF, INT, PM, TEL, LAN, TACmd, LAAM BN Cmd, LCN, AOC-2, LWCN, LTCN, DIV FSC	12
168. FS Coord	FF, INT, PM, LAN, TACmd, DAS, ACN, TATC, TAD, HD, RGT FSC, DIV FSC	12
169. Sup Arms Info	FF, INT, PM, LAN, DAS, ACN, RGT FSC, DIV FSC	8
170. Ground Sup	PM	1
171. AMO Status	FF, PM, SB	3
172. Ordnance	FF, INT, PM, TEL, LAN, TACmd, DAS, RGT FSC, DIV FSC	9
173. TAOC Resup	INT, PM, TACmd	3
174. HAWK Inv. Rep	FF, INT, TEL, TACmd	4
175. HAWK Emerg.	FF, INT, PM, TEL, LAN, TACmd, AOC-1, AOC-2, AAC	9
176. HAWK Admin	FF, INT, PM, TEL, TACmd, LAAM BN Cmd	6
177. HAWK CMS	FF, PM, TEL	3
178. HAWK Reload	FF, INT	2
179. LAAD Inv. Rep	FF, INT, TEL, LAN, TACmd, LAAM BN Cmd, LCN, LWCN, LTCN, DAS, DIV FSC	11
180. LAAD Emerg.	INT, PM, TEL, LAN, TACmd, LAAM BN Cmd LCN, LWCN, LTCN, DAS, DIV FSC	11
181. LAAD Admin	FF, INT, PM, TEL, LAN, TACmd, LAAM BN Cmd, LCN, LWCN, LTCN, DAS, Div FSC	12

APPENDIX B

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REVIEWERS' COMMENTS

On the recommendation of the Academic Advisor for this thesis, a draft of the thesis was provided to selected individuals knowledgeable in the Marine Air Command and Control System for comment. Their comments and perspectives on the issues addressed by the thesis are included here.

Comments on the thesis from Colonel R.A.G. Berns, Head, Collective Standards Division, Training Department, Headquarters, U.S. Marine Corps:

> "The thesis' author took an awfully long time to get to a short, but valid, recommendation. The thesis is based on an analysis that was incomplete (air defense emphasis), biased (limited subject matter expert field), and flawed (lack of a clear definition of what should have been looked for). I obviously have misgivings with the CNA study. Further, as you are well aware, we are beginning to articulate what the commander (TAC) really needs to properly employ his assets, an important effort by itself.
>
> The realization of the deficiencies of a manual system addressed in Chapter 1 was realized earlier than the Viet Nam involvement. In the mid 1960's Litton produced the AN/TYQ-2 ROC, and a development team was put together, with Colonels Johnny Johnson and Red Yazzi participating.
>
> The author's contention that the system had no design is correct.

The major flaw I see in the CNA study is the absence of the vital element of criticality. It also only looked at what was, not what should be. Do the critical elements flow to the right people in a timely fashion? Can we articulate what those critical elements are? The information elements identified are critical to whom? The operator who had never been trained properly in what critical items to look for; the TAC who had never tried to employ multiple aircraft and systems as an integrated supporting arm; or the supported individual who was left begging?

I concur with the author's recommendations on taking a system's approach to improving the MACCS. His recommendations for establishing a ROC and COE are strongly concurred in."

The following comments on the thesis were provided by Lieutenant Colonel K.H. Stivers, Director, Light Armored Vehicle Test Directorate:

"Major Noble points out rather succinctly the "waste and abuse" that we have allowed to occur within the Marine Air Command and Control System over the past twenty years. It is disconcerting to one who believes in the "System's" capabilities to realize that we have been spinning our wheels to a large degree for such a long time. The thesis problem is real and must be addressed. In fact, Major Noble has nailed down only the tip of the iceberg. I agree fully with his limited approach since to include all variables of the problem would make it entirely too complex for this endeavor. His recommendation for solutions are straight forward and to the point, and must be attacked if the system concept of Air Command and Control is to survive.

Having been personally involved in the CNA study, I am acutely aware of the methods used and the circumstances under which the data was collected. Considering the fact that nothing approaching this had ever been attempted, the analysts were saddled with a formidable task. This lead to some assumptions which likely skewed certain data. However, I must point out that even with some faulty assumptions and data, the basic thesis problem exists and the final recommendations remain sound.

We have continuously espoused that Air Command and Control was a centralized command and decentralized control system. However, what normally happens during training (and we tend to fight like we train) is an enormous volume of information is demanded from the central command agency. This in turn places an increased burden on the agencies down the line (TAOC,DASC,etc.). What develops is an extreme case of micro-management. Information that is normally dealt with at a lower level is forwarded up the chain even though the action (and resultant effect) has already taken place. In other words, information is being forwarded for information's sake rather than for critical decision making. This tends to skew the requirement for information, the number of operators who possess it, and the paths it must transit. This sort of action tends to be self-propagating. The more it occurs, the more information is required and thus the greater the critical need. I think this was likely a fallacy in CNA's methodology, which tended to ask personnel what they needed and how critical that need was. The most significant drawback to the entire issue occurs when the intensity of the conflict increases. As the threat level increases and the attendant pucker factor goes up, the natural desire is for more information faster. The converse actually happens. Due to time and system overload, decisions which in training are made at a high level migrate to subordinate agencies. Critical paths become overloaded with easy to pass information, and critical data falls into numerous black holes. All done because the tactical situation warrants action and not reaction.

To complicate the problem - MACCS agencies, which are functional nodes within the system, (they are operationally under the control of the Senior Agency, regardless of Service) are also administratively and logistically supported by their parent command. This command demands a combination of the same data required by the System plus additional requirements. This goes a long way towards duplicating and complicating the information flow. Bottom line on this dissertation is that the determination of critical needs cannot solely be determined on what some say he needs but rather on what the System <u>requires</u> to provide the <u>appropriate</u> agency with a tactical decision-making capability. There is no room for micro-management.

I fully understand Major Noble's decision not

to deal with joint operational requirements. However, I do feel the real world scenario within which a MACCS would be employed dictates the review of these problems. Again the way we practice is the way we fight. Quite often duplicate information is passed both to the Senior Agency (i.e. Air Force TACC) plus other Marine/Navy agencies (TADC ashore/ afloat). It is very likely that this is overkill and does nothing more than cause inordinate delays and overly complicate the information flow with very little real enhancement to tactical decision making.

Major Noble has tackled a complex problem that has been years in the making and which has cost the Marine Corps millions of dollars in attempts to resolve. His solutions are simply stated but point out the action required for all to see. Do we need a Marine Air Command and Control System? The answer is yes. But let us not regress to old methods. We cannot continue to solve yesterday's problems with tomorrow's equipment. That mind set is what brought us with the current dilemma. We must force ourselves to look long and hard at tomorrow's needs, organizational requirements, available structure, and technology. Only then can we hope to regain the tactically viable system that exists. Then let's get on with the problem solving quickly before we wind up with nothing but empty head sets."

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